STELLA MARY'S COLLEGE OF ENGINEERING

(Accredited by NAAC, Approved by AICTE - New Delhi, Affiliated to Anna University Chennai)

Aruthenganvilai, Azhikal Post, Kanyalumari District, Tamilnadu - 629202.

OAT552 INTERNAL COMBUSTION ENGINES

(Anna University: R2017)

Prepared By

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DEPARTMENT OF MECHANICAL ENGINEERING

2021-2022 (ODD)

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Aruthenganvilai, Kallukatti Junction Azhikal Post, Kanyakumari District-629202, Tamil Nadu.

DEPARTMENT OF MECHANICAL ENGINEERING

COURSE MATERIAL

REGULATION	**2017**
YEAR	**III**
SEMESTER	**05**
COURSE NAME	**INTERNAL COMBUSTION ENGINES**
COURSE CODE	**OAT552**
NAME OF THE COURSE INSTRUCTOR	**Mr. P. VIJAYAN**

SYLLABUS:

UNIT I INTRODUCTION IC ENGINE 9

Introduction, Types of IC engines, Constructional details IC engine, working, principles – 2 & 4 stroke engines, Cycles – Air standard cycles, Fuel air cycles and actual cycles, Actual Indicator diagram for four stroke and two stroke engines, General fuel properties, ignition properties – octane and cetane rating, Materials for engine components

UNIT II PETROL ENGINES 9

Working and constructional details of petrol engines, Carburetor – constructional and working, types of carburetors, additional features in modern carburetor, A/F ratio calculation, Petrol Injection - introduction, Ignition – introduction and requirements, Battery and magneto coil ignition system, Electronic ignition system, Stages of combustion in petrol engines, Combustion chambers for petrol engine, formation of knock in petrol engine

UNIT III DIESEL ENGINES 9

Working and constructional details of diesel engines, fuel injection – requirements, types of injection systems – inline, distributor pumps, unit injector, Mechanical and pneumatic governors. Fuel injector, Types of injection nozzles, Spray characteristics. Injection timing, Split and multiple injection, Stages of combustion in Diesel engines, direct and indirect combustion chambers for diesel engine, knocking in diesel engine, Introduction on supercharging and turbocharging

UNIT IV COOLING AND LUBRICATION 9

Requirements, Types- Air cooling and liquid cooling systems, forced circulation cooling system, pressure and Evaporative cooling systems, properties of coolants for IC engine. Need of lubrication, Lubricants for IC engines - Properties of lubricants, Types of lubrication – Mist, Wet and dry sump lubrication systems.

UNIT V MODERN TECHNOLOGIES IN IC ENGINES 9

HCCI Engines – construction and working, CRDi injection system, GDI Technology, E - Turbocharger, Variable compression ratio engines, variable valve timing technology, Fuel cell, Hybrid Electric Technology

TEXT BOOKS :

1. Ganesan.V., Internal Combustion Engines, Tata McGraw Hill Publishing Co., New York,1994.
2. Ramalingam. K. K., Internal Combustion Engines, Scitech publications, Chennai, 2003

REFERENCES:

1. Ellinger, H.E., Automotive Engines, Prentice Hall Publishers, 1992.
2. Heldt.P.M. High Speed Combustion Engines, Oxford IBH Publishing Co., Calcutta,1975.
3. Obert E.F., Internal Combustion Engines Analysis and Practice, International Text Books:Co., Scranton, Pennsylvania, 1988.
4. William. H. Crouse, Automotive Engines, McGraw Hill Publishers, 1985.

Course Outcome Articulation Matrix

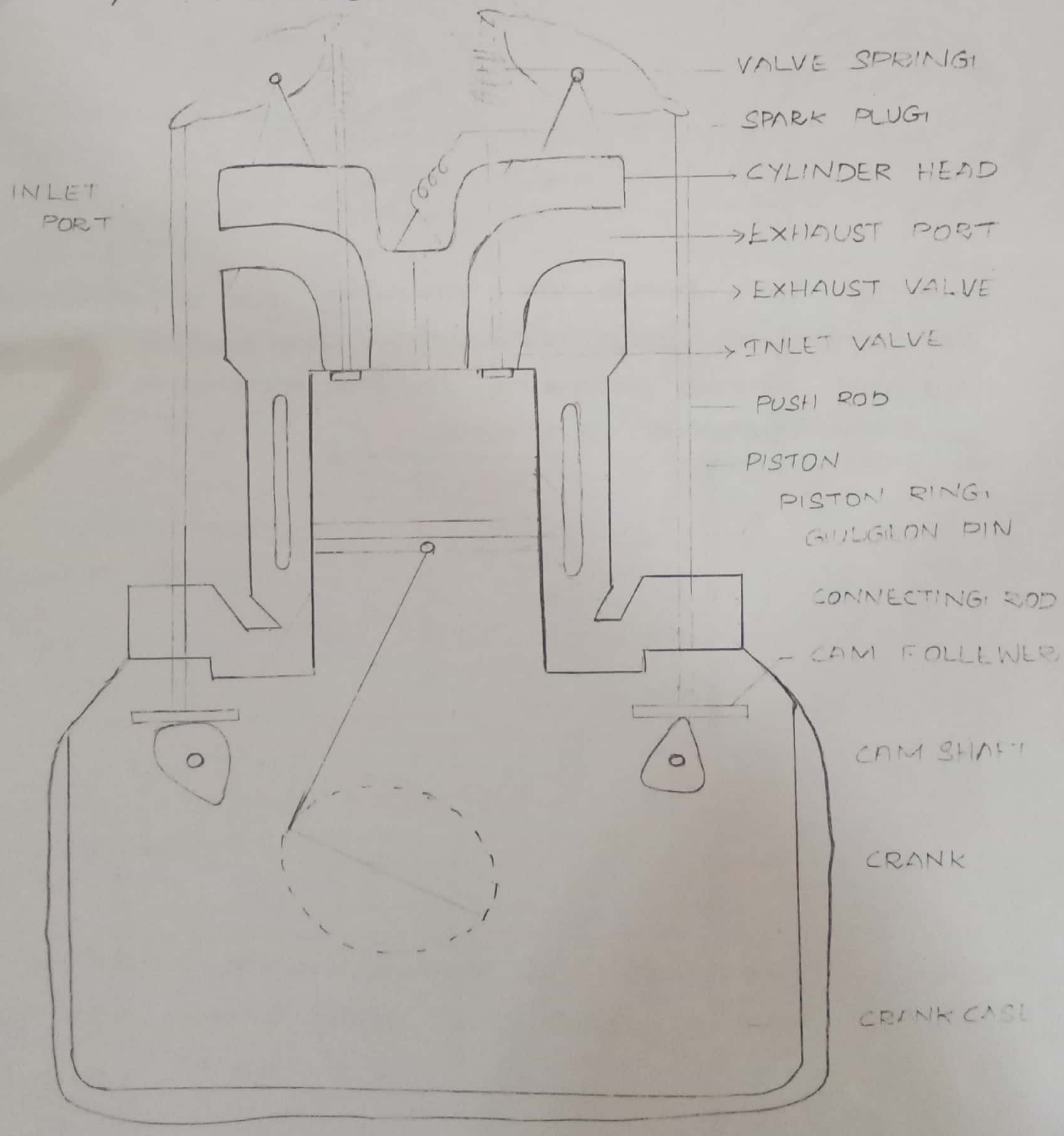
	Program Outcome												***PSO***		
Course Code / CO No	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***	***1***	***2***	***3***
OAT552 / C310.1	3	1	1	0	0	1	1	0	0	0	0	2	2	2	1
OAT552 / C310.2	3	1	1	0	0	1	1	0	0	0	0	2	2	2	1
OAT552 / C310.3	3	1	1	0	0	1	1	0	0	0	0	2	2	2	1
OAT552 / C310.4	3	1	1	0	0	1	1	0	0	0	0	2	2	2	1
OAT552 / C310.5	3	1	1	0	0	1	1	0	0	0	0	2	2	2	1
Average	3	1	1	0	0	1	1	0	0	0	0	2	2	2	1

1/19

1. INTERNAL COMBUSTION ENGINE

IMPORTANT MAIN PART OF IC ENGINE :-

Cylinder head, cylinder, piston, connecting rod, crank, compression ring, oil ring, gudgeon pin, inlet valve, Exhaust valve, piston pin, cam, rocker arm, Push rod



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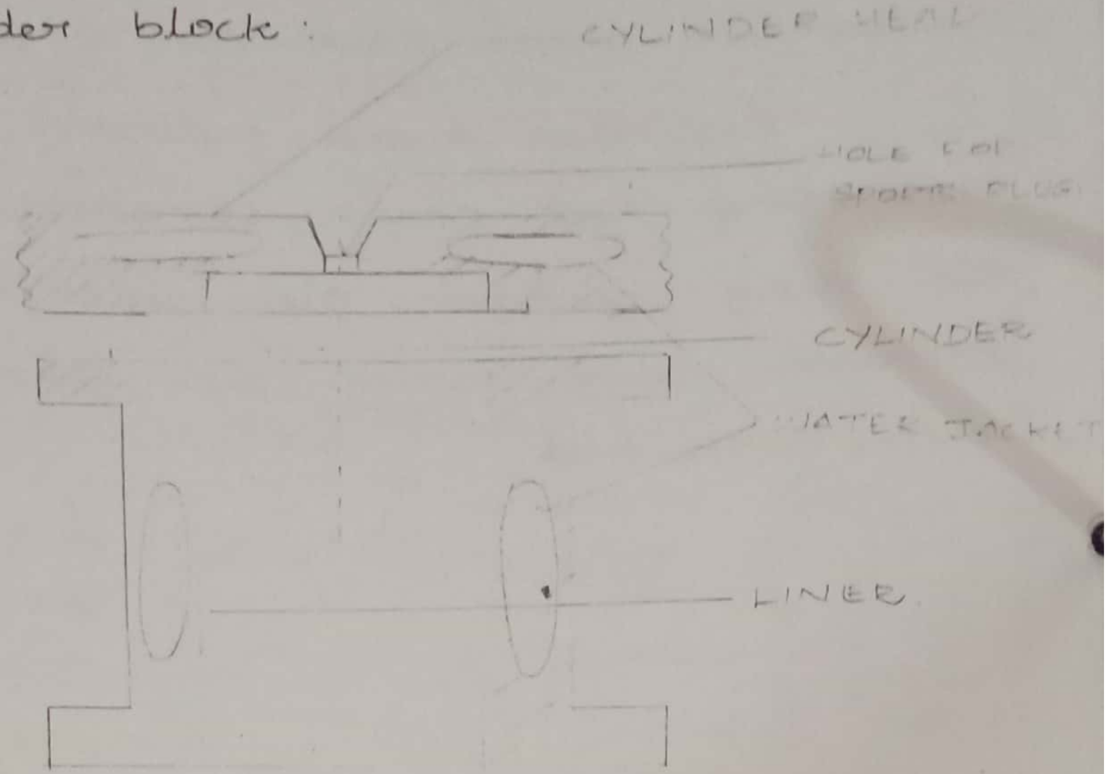
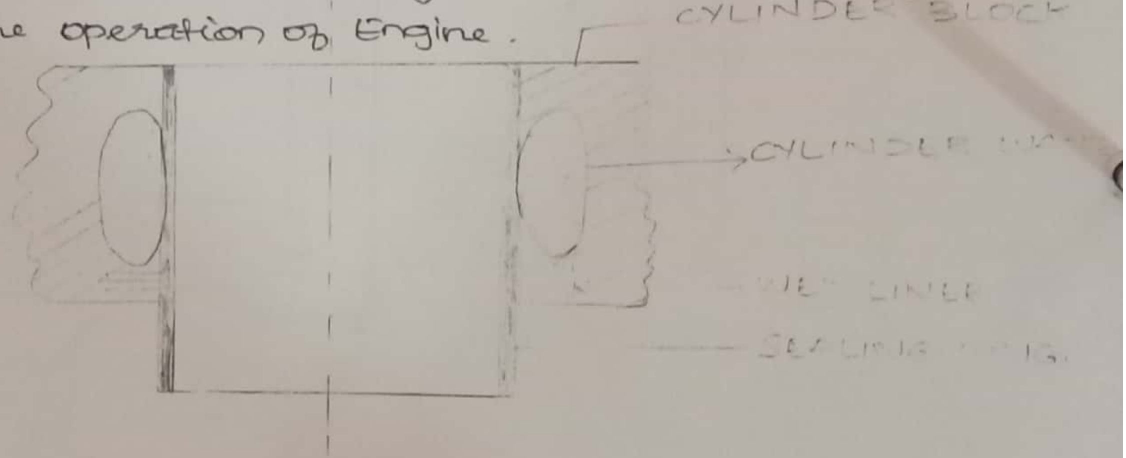
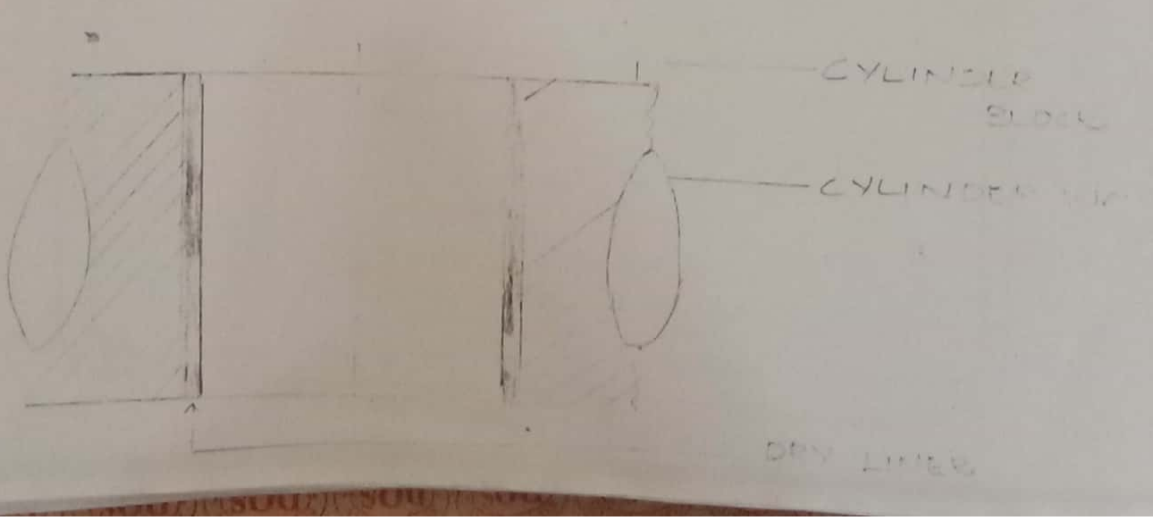
IMPORTANT PARTS :-

1. Cylinder block :

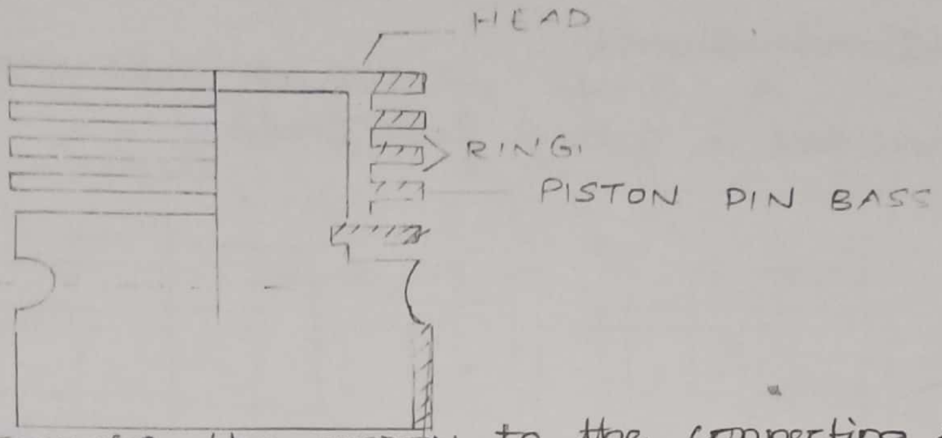


* It has ports or opening for valves and Passages for water circulation for cooling. The volume cylinder varies according to the movement of piston and the operation of Engine.



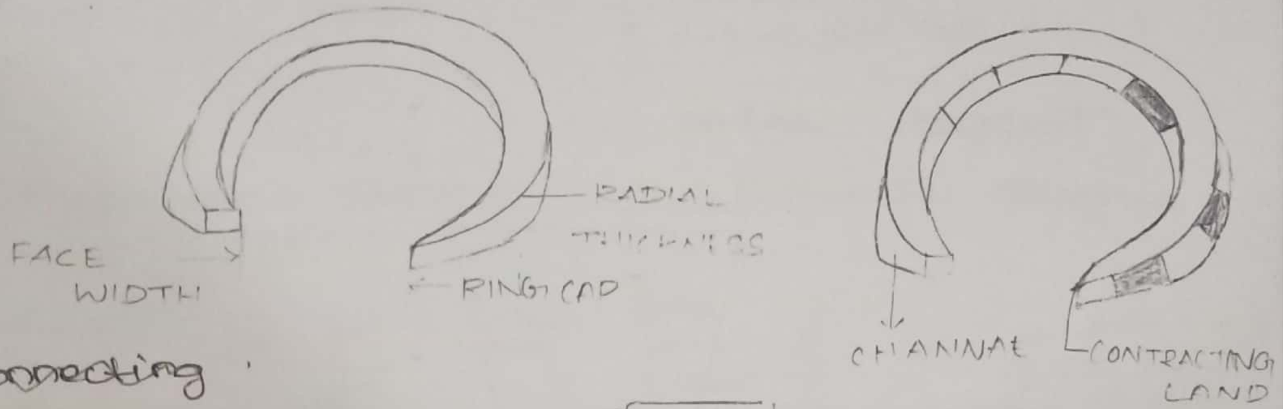


Piston :-

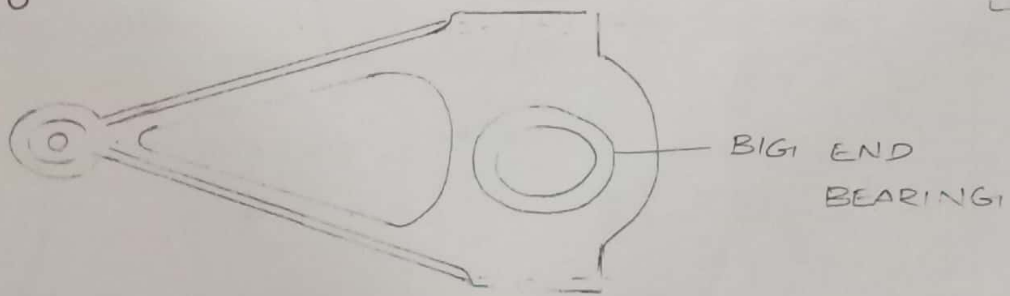


*. It transfer the energy to the connecting rod during the working stroke

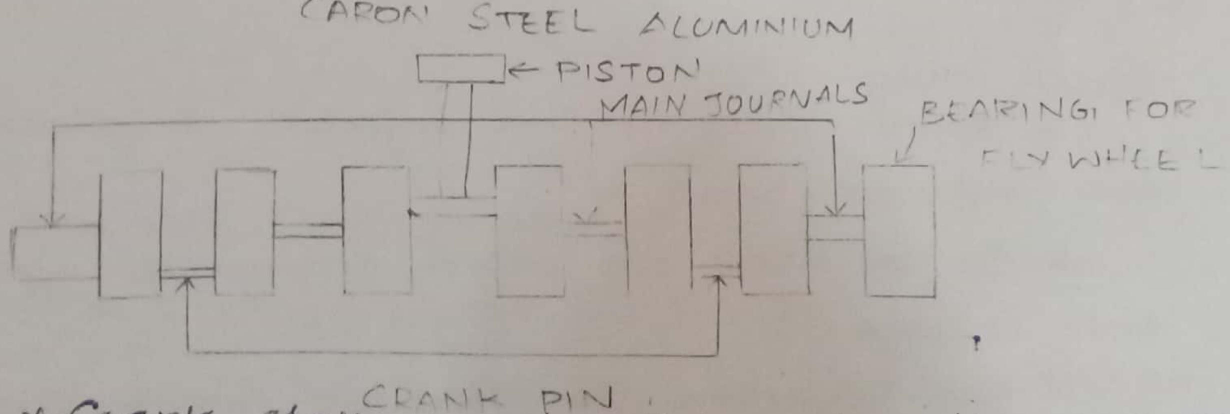
Piston Rings :-



Connecting .



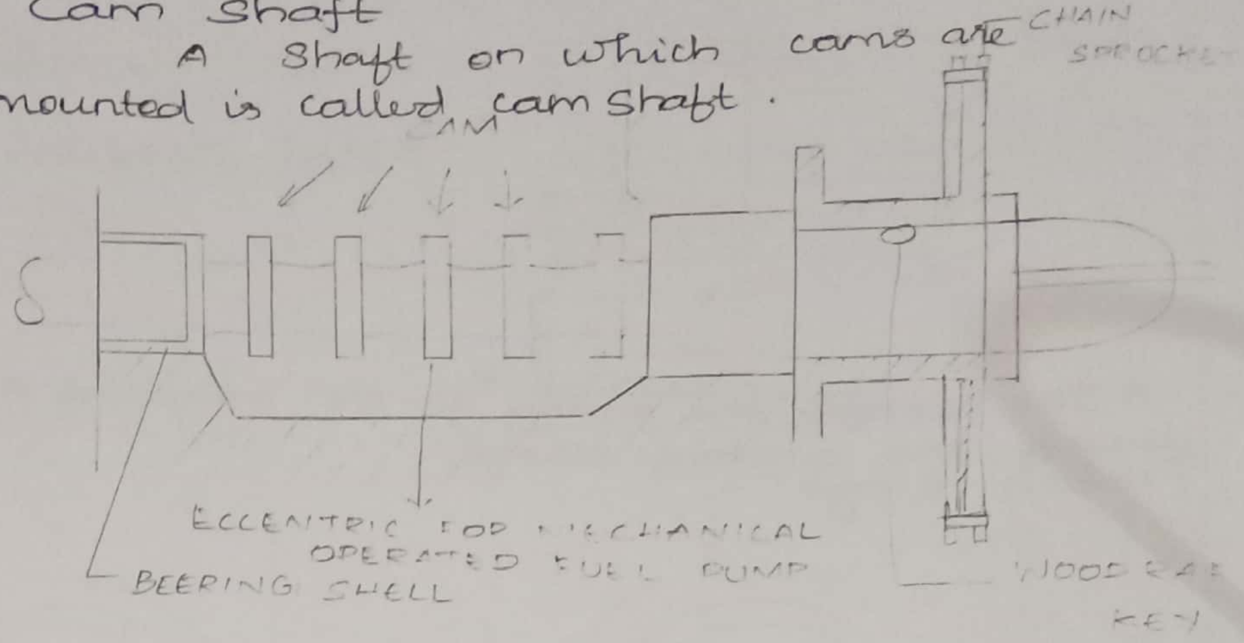
Crank Shaft .



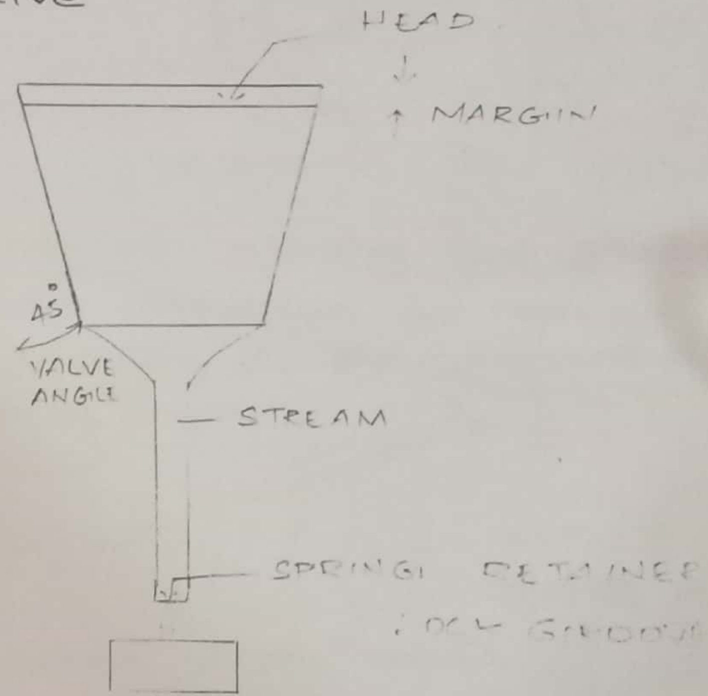
*. Crank shaft converts the reciprocating movement of the piston into the rotary motion of the engine shaft .

Cam shaft

A shaft on which cams are mounted is called cam shaft.



Tappet valve



Spark plug

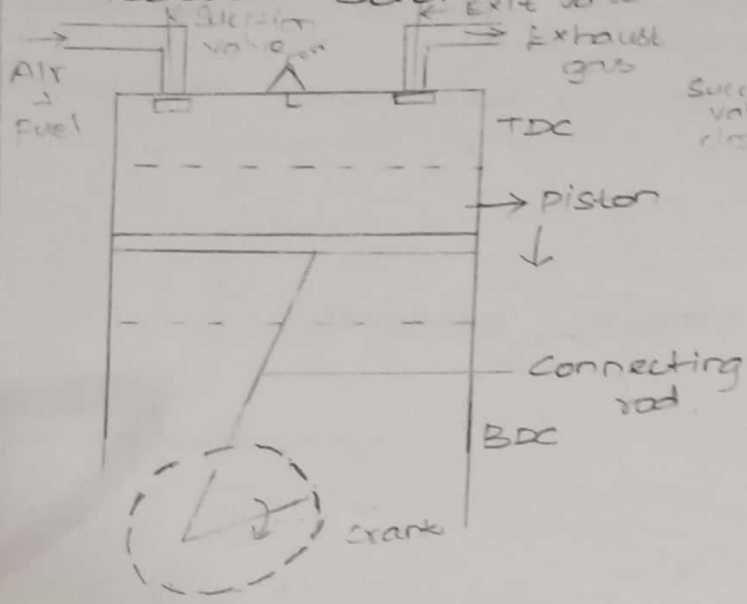
* Spark plug or Fuel injector is placed in the cylinder head.

* It is used in petrol engine to ignite the charge.

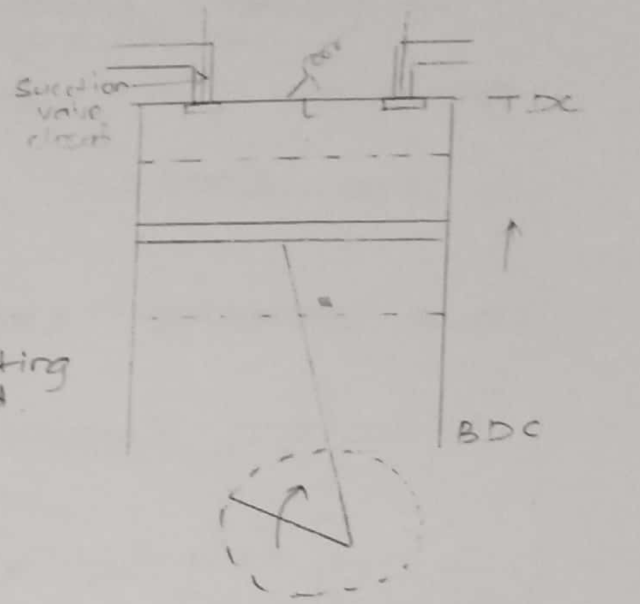
* Fuel injector is used in diesel engine to inject the diesel inside the cylinder

FOUR STROKE PETROL ENGINE

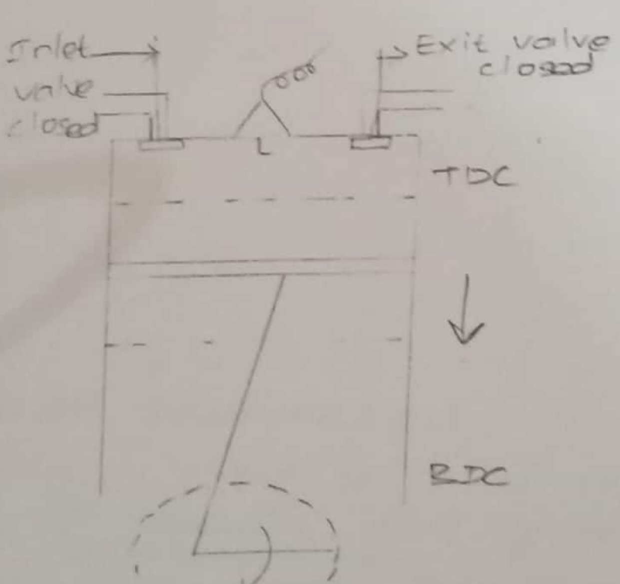
i) Sucction Stroke



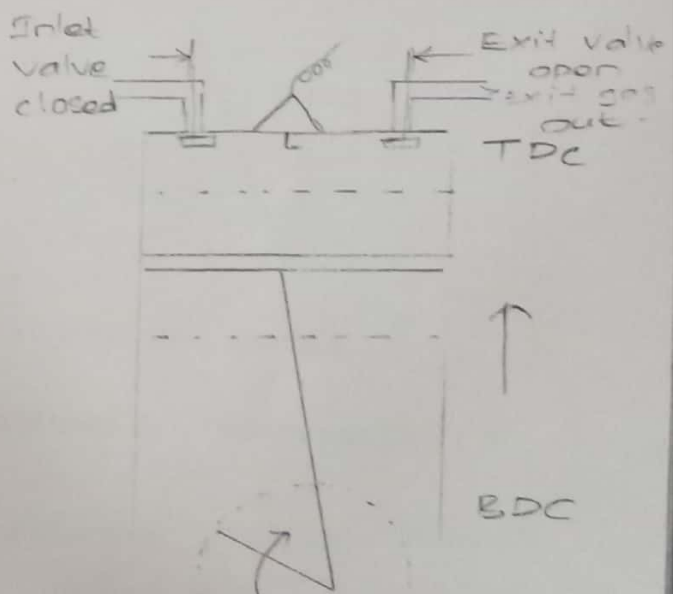
ii) compression Stroke



iii) Expansion Stroke



iv) Exhaust Stroke.



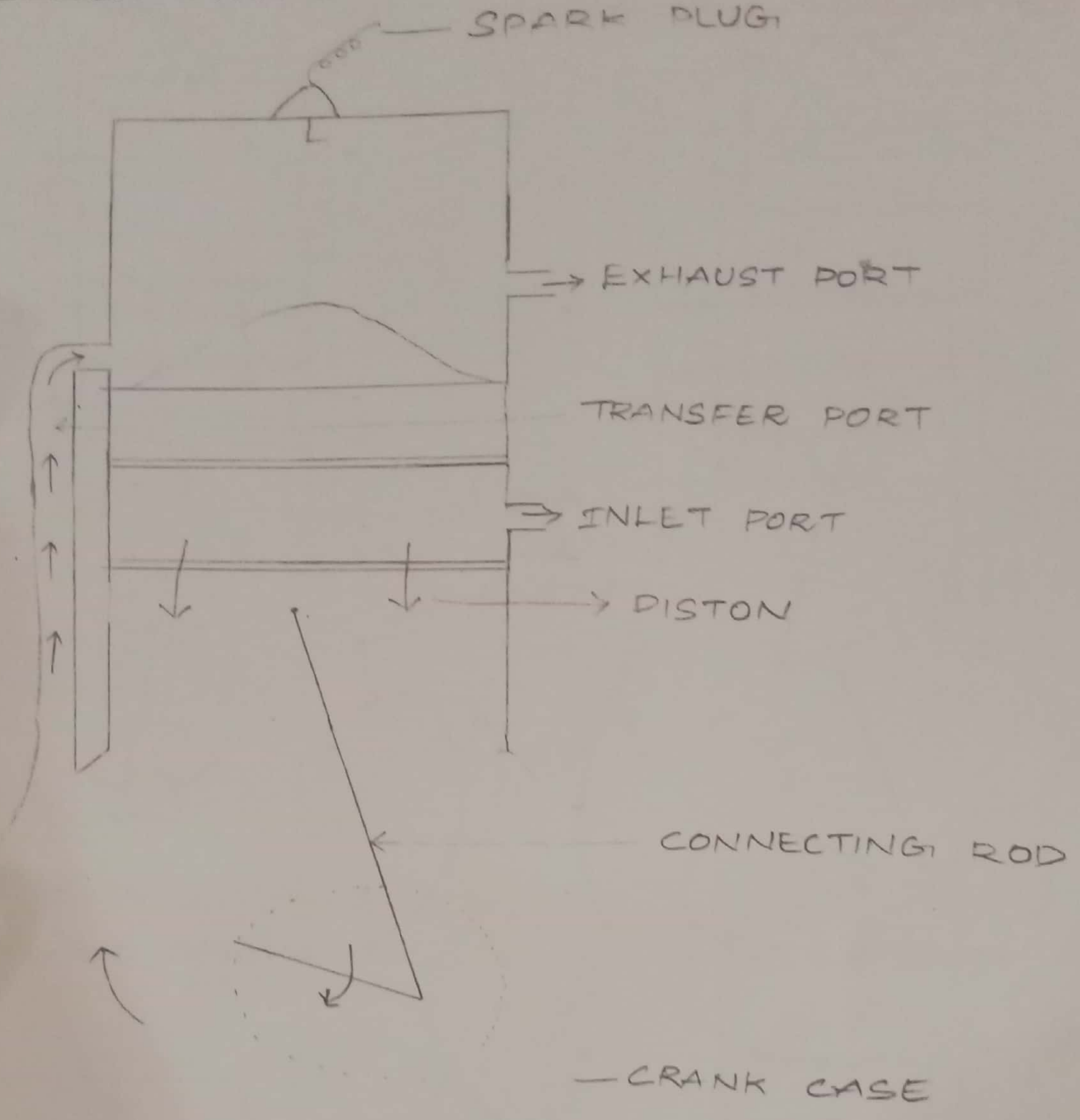
* Air Fuel ratio - 10:1

* Firing order - 1, 3 4 2

* At the end of the compression the temperature is 250 — 300°c and pressure is 12 bar (10-15 bar).

TWO STROKE ENGINE : (PETROL)

Sucction Stroke



During the first stroke piston moves upward from BDC to TDC. When the piston is at BDC, the partially compressed air-fuel mixture from crank case enters into the cylinder through transfer port.

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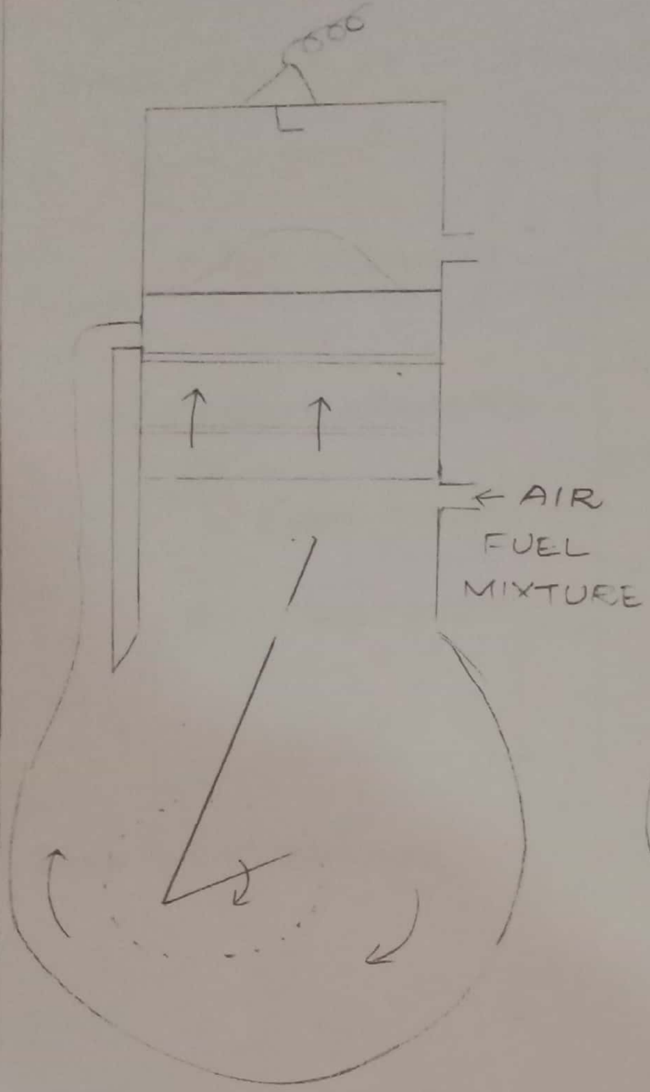
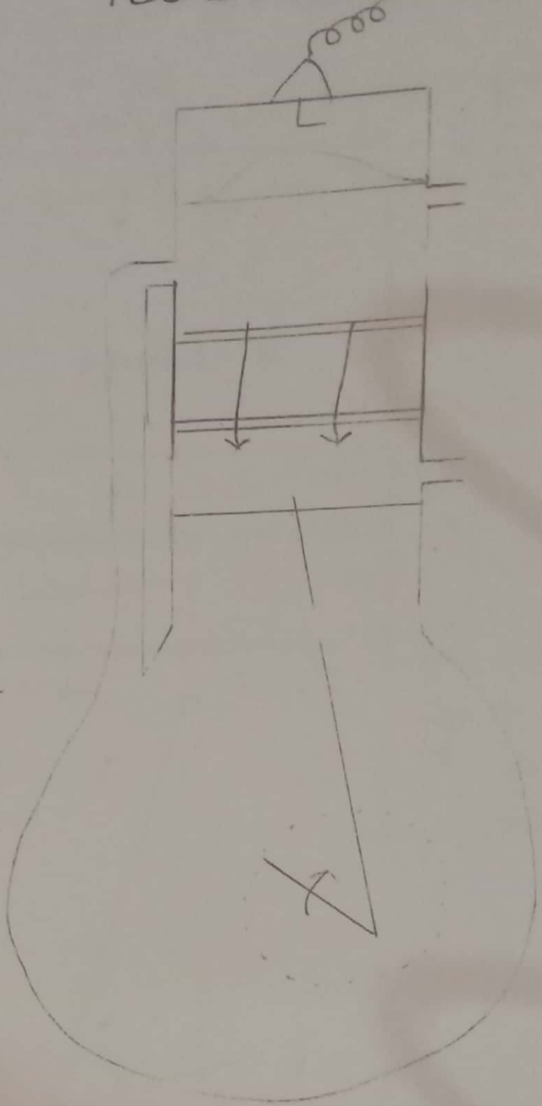
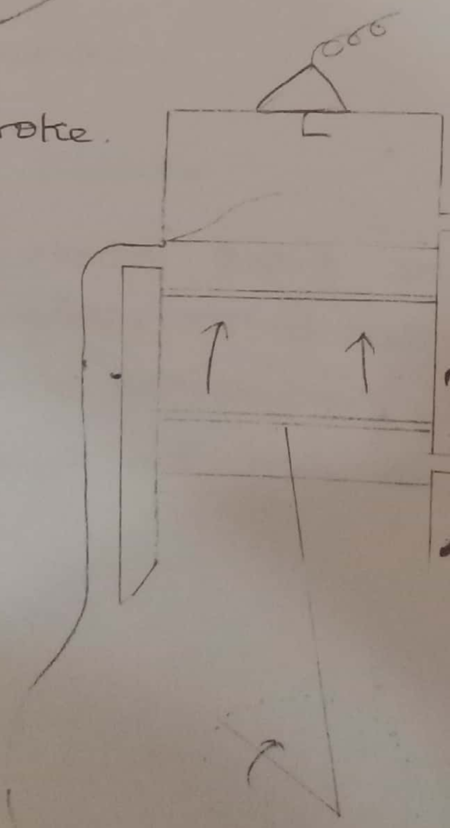
Compression stroke



Power stroke



Exhaust stroke.



* When the piston moves to the BDC, the fresh air fuel mixture from crank case enters into the cylinder to sweep out the burnt gases. The process of sweeping out the exhaust gas with the help of fresh air fuel mixture is

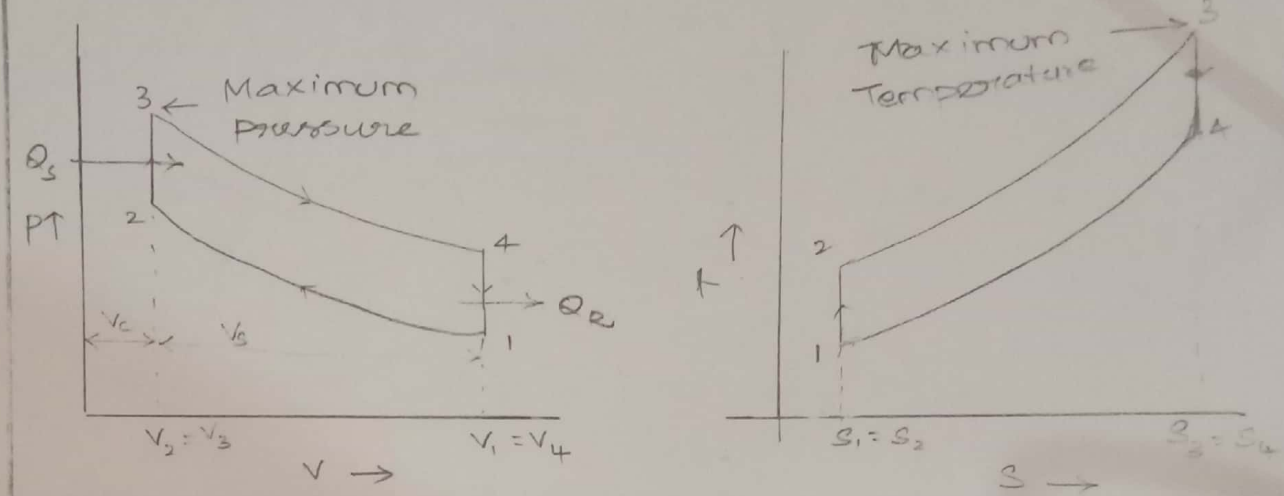
AIR CYCLE :-

The cycle is defined as the series of operation or processess performed on the system, so that the system attain its original state.

OTTO CYCLE :-

PV diagram :-

TS diagram



1-2 Adiabatic ~~process~~ compression

2-3 constant volume heat supply

3-4 Adiabatic expansion.

4-1 constant volume heat rejection.

Adiabatic process :-

Relation b/w pressure and volume

$$\frac{P_2}{P_1} = \left(\frac{V_1}{V_2}\right)^{\gamma}$$

Relation b/w Volume and Temperature

$$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1}$$

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Relation b/w pressure and Temperature

$$\frac{P_2}{P_1} = \left(\frac{T_2}{T_1}\right)^{\frac{\gamma-1}{\gamma}}$$

constant pressure, volume, temperature unknown value find out using this formula:-

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$\eta = \frac{W}{Q_s}$$

$$Q_s = mC_v(T_3 - T_2)$$

$$Q_R = mC_v(T_4 - T_1)$$

$$\eta_{otto} = 1 - \frac{1}{(r)^{\gamma-1}}$$

where r - compression ratio.

$$r = \frac{V_1}{V_2} \text{ (or) } \frac{V_c + V_s}{V_c}$$

$$P_m = P_1 V_3 \left(\frac{K-1}{\gamma-1}\right)\left(\frac{r^{\gamma-1} - 1}{r-1}\right)$$

where k - pressure ratio

$$\frac{P_3}{P_2} = k.$$

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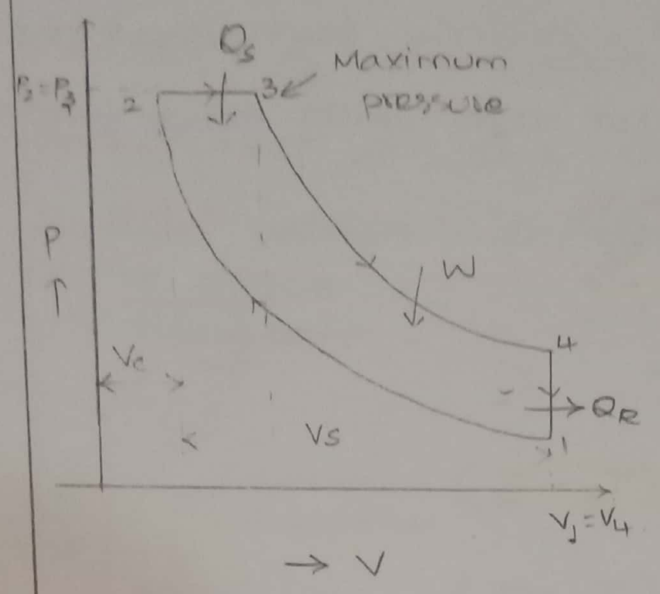
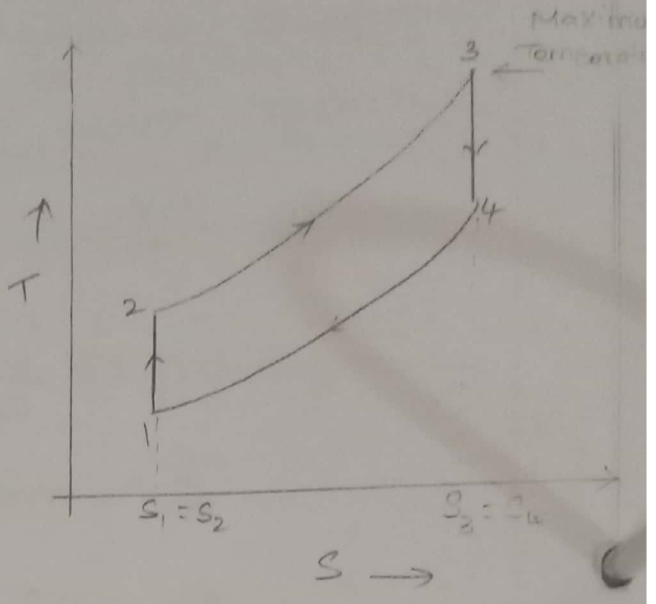
DIESEL CYCLE :-

PV diagram

TS diagram





1-2 Adiabatic compression

2-3 constant pressure heat supply

3-4 Adiabatic Expansion

4-1 ~~Adiabatic~~ Constant volume heat rejected.

$$\eta_{die} = 1 - \frac{1}{\gamma (r)^{\gamma - 1}} \left[\frac{\rho^{\gamma} - 1}{\rho - 1} \right]$$

$$P_m = \frac{P_1 r^{\gamma} \left[\gamma (\rho - 1) - r^{1-\gamma} (\rho^{\gamma} - 1) \right]}{(\gamma - 1)(r - 1)}$$

where, $\rho = \frac{V_3}{V_2}$ ρ - cut off ratio.

$Q_s = m C_p (T_3 - T_2)$

$Q_R = m C_v (T_4 - T_1)$

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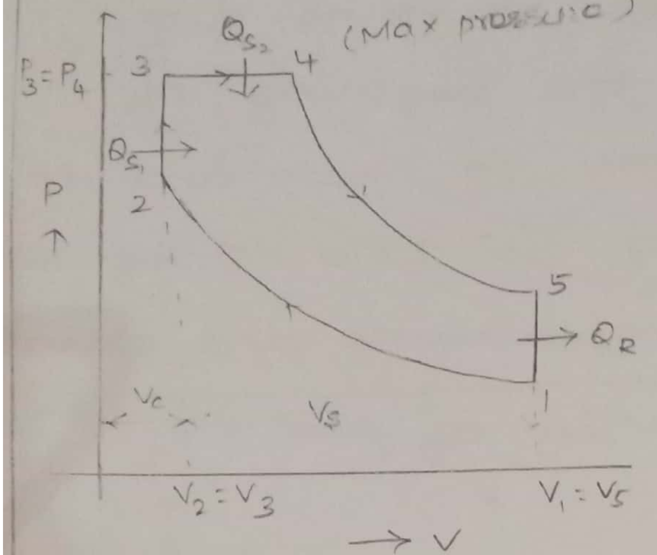
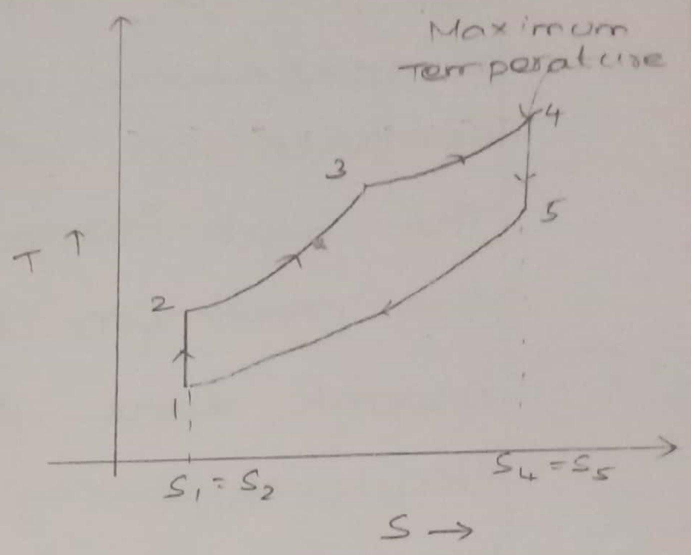
DUAL CYCLE

PV diagram



TS diagram.



1-2 Adiabatic compression

2-3 constant volume heat supply

3-4 constant pressure heat supply

4-5 Adiabatic expansion.

5-1 constant volume heat Rejection.

Heat supply $Q_{S1} = mc_v(T_3 - T_2)$

$$Q_{S2} = mc_p(T_4 - T_3)$$

$$Q_S = Q_{S1} + Q_{S2}$$

Heat rejected $Q_R = mc_v(T_5 - T_1)$.

$$\eta_{dual} = 1 - \frac{1}{(r)^{\gamma-1}}\left[\frac{k\rho^{\gamma} - 1}{(k-1) + \gamma k(\rho - 1)}\right]$$

$$P_m = \frac{P_1 r^{\gamma}\left[k\gamma(\rho-1) + (k-1) - r^{1-\gamma}(k\rho^{\gamma} - 1)\right]}{(\gamma-1)(r-1)}.$$

1. An otto cycle has compression ratio of 7. The initial pressure and temperature at the begining of compression stroke is 1 bar and 40°C The heat Supplied is 2510 kJ/kg. Find

i) the maximum temperature and pressure

ii) work done per kg of air

iii) cycle efficiency

iv) Mean effective pressure

Take $C_v = 0.713$ kJ/kgK. and $R = 0.287$

Given Data:- (Otto cycle)

compression ratio $\gamma = 7$

$P_1 = 1$ bar

$= 1 \times 10^2$ kN/m²

$T_1 = 40°C$

$= 313$ K

$Q_s = 2510$ kJ/kg

$C_v = 0.713$ kJ/kgK

$R = 0.287$ kJ/kgK.

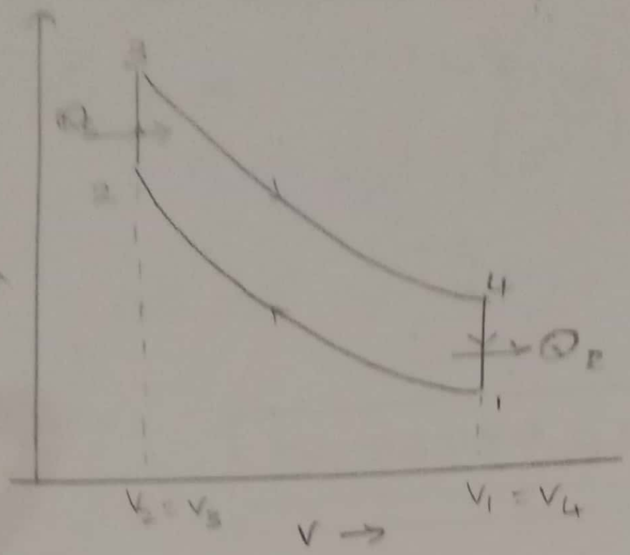
To Find:-

P_3, T_3

W

η

P_m



Solution:-

$P_1 V_1 = mRT_1$

$V_1 = \frac{1 \times 0.287 \times 313}{100}$

$\boxed{V_1 = 0.898 \ m^3}$

$V_1 = V_4$

$r = \frac{V_1}{V_2} \Rightarrow 7 = \frac{0.898}{V_2}$

$\boxed{V_2 = 0.128 \ m^3}$

1-2 process

Relation b/w pressure and volume

$\frac{P_2}{P_1} = \left(\frac{V_1}{V_2}\right)^{\gamma}$

$\frac{P_2}{100} = (7)^{1.4}$

$\boxed{P_2 = 1524.53 \ kN/m^2}$

Relation b/w temperature and volume

$$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1}$$

$$\frac{T_2}{313} = (7)^{0.4}$$

$$\boxed{T_2 = 681.68\ K}$$

Process 2-3

$$Q_S = mC_v(T_3 - T_2)$$

$$2510 = 1 \times 0.713\left(T_3 - 681.68\right)$$

$$\boxed{T_3 = 4202.01\ K}$$

$$\frac{P_2 \cancel{V_2}}{T_2} = \frac{P_3 \cancel{V_3}}{T_3} \qquad (V_2 = V_3)$$

$$\frac{1524.53}{688} = \frac{P_3}{681.6}$$

$$\frac{1524.53}{681.68} = \frac{P_3}{4202.01}$$

$$\boxed{P_3 = 9397.50\ kN/m^2}$$

$$\eta = 1 - \frac{1}{(r)^{\gamma-1}}$$

$$= 1 - \frac{1}{(7)^{1.4-1}}$$

$$\boxed{\eta = 54.08\%}$$

$P_m =$

$$\eta = \frac{W}{Q_s}$$

$$0.5408 = \frac{W}{2510}$$

$$\boxed{W = 1357.40 \text{ kJ/kg}}$$

$$P_m = \frac{\text{work done}}{\text{Swept volume}} = \frac{W}{V_1 - V_2}$$

$$= \frac{1357.40}{0.898 - 0.128}$$

$$\boxed{P_m = 1762.85 \text{ kN/m}^2}$$

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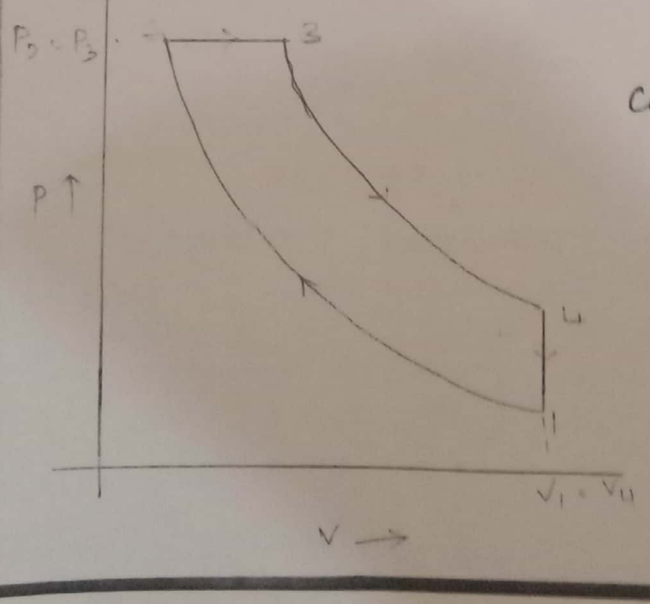
2. Air standard diesel cycle has a compression ratio of 12 and cut off takes place at 5.5% of stroke. Calculate the air standard efficiency of cycle.



$r = 12$

Cutt off $= 5.5\, V_s$

$$r = \frac{V_1}{V_2} = 12$$

$$V_1 = 12 V_2$$

$$(V_3 - V_2) = 0.055 \times (12V_2 - V_2)$$

$$= 0.055 \times 11 V_2$$

$$= 0.605 V_2$$

$$V_3 = 1.605 V_2$$

Cut off ratio $\rho = \frac{V_3}{V_2}$

$$= \frac{1.605 V_2}{V_2}$$

$$\rho = 1.605$$

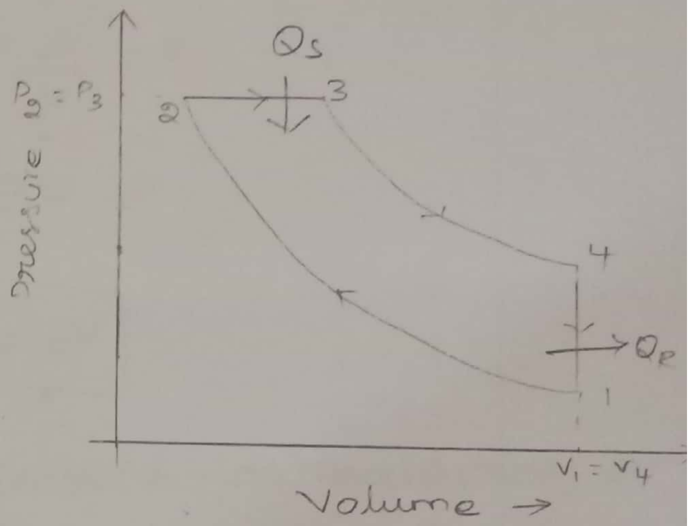
$$\eta = 1 - \frac{1}{\gamma (r)^{\gamma - 1}} \left[\frac{\rho^{\gamma} - 1}{\rho - 1} \right]$$

$$= 1 - \frac{1}{1.4 (12)^{1.4-1}} \left[\frac{1.605^{1.4} - 1}{1.605 - 1} \right]$$

$$\boxed{\eta = 59.6}$$

3 In an engine working on diesel cycle the inlet temperature and pressure are 17°c and 1 bar respectively. The pressure at the end of adiabatic compression is 35 bar. The ratio of Expansion is after constant pressure heat addition is 5. Calculate the heat addition, rejection, the efficiency of the cycle and mean effective pressure.

Given Data:-



$P_1 = 1$ bar

$= 1 \times 10^2 kN/m^2$

$T_1 = 17°c = 17 + 273$

$= 290 k.$

$P_2 = P_3 = 35$ bar

$= 35 \times 10^2 kN/m^2$

$$\frac{V_4}{V_3} = \frac{V_1}{V_3} = 5$$

To Find :-

Q_S, Q_R, η, P_m

Solution:- Process 1-2

Relation between pressure and Volume

$$\frac{P_2}{P_1} = \left(\frac{V_1}{V_2}\right)^{\gamma} = r^{\gamma}$$

$$\left(\frac{35\times10^{2}}{1\times10^{2}}\right)^{\left(\frac{1}{1\cdot4}\right)} = r$$

$$\boxed{r = 12.67}$$

$$P_1V_1 = mRT_1$$

$$V_1 = \frac{1\times0.286\times290}{1\times10^{2}}$$

$$\boxed{V_1 = 0.832\ m^3}$$

$$r = \frac{V_1}{V_2}$$

$$V_2 = \frac{0.832}{12.67}$$

$$\boxed{V_2 = 0.065\ m^3}$$

Relation b/w Temperature and volume

$$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1} = r^{\gamma-1}$$

$$T_2 = 290\times\left(12\cdot67\right)^{1\cdot4-1}$$

$$\boxed{T_2 = 800.77\ k}$$

Process 2-3

$$\frac{\cancel{P_2}V_2}{T_2} = \frac{P_3V_3}{T_3} \qquad (P_2 = P_3)$$

$$\frac{V_1}{V_3} = 5$$

$$\therefore V_3 = \frac{0.832}{5}$$

$$\boxed{V_3 = 0.166\ m^3}$$

$$T_3 = \frac{0.166 \times 800.77}{0.065}$$

$$\boxed{T_3 = 2045.04\ k}$$

$$\rho = \frac{V_3}{V_2}$$

$$= \frac{0.166}{0.065}$$

$$\boxed{\rho = 2.55}$$

Process 3-4

Relation b/w volume and Temperature

$$\frac{T_4}{T_3} = \left(\frac{V_3}{V_4}\right)^{\gamma-1}$$

$$T_4 = 2045.04 \left(\frac{1}{5}\right)^{1.4-1}$$

$$\boxed{T_4 = 1074.27\ k}$$

Relation b/w pressure and volume

$$\frac{P_4}{P_3} = \left(\frac{V_3}{V_4}\right)^{\gamma}$$

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$$P_4 = 35 \times 10^2 \left(\frac{1}{5}\right)^{1.4}$$

$$\boxed{P_4 = 367.71 \ kN/m^2}$$

$$\eta_{die} = 1 - \frac{1}{\gamma (r)^{\gamma-1}} \left[\frac{\rho^{\gamma} - 1}{\rho - 1}\right]$$

$$= 1 - \frac{1}{1.4 (12.67)^{0.4}} \left[\frac{2.55^{1.4} - 1}{2.55 - 1}\right]$$

$$\boxed{\eta_{die} = 54.75 \%}$$

1.74

Mean effective pressure

$$P_m = P_1 r^{\gamma} \frac{\left[\gamma(\rho - 1) - r^{1-\gamma}(\rho^{\gamma} - 1)\right]}{(\gamma - 1)(r - 1)}$$

$$= 1 \times 10^2 \times (12.6)^{1.4} \frac{\left[1.4(2.55 - 1) - (12.67)^{1-1.4} (2.5\right.}{(1.4 - 1)(12.67 - 1)}$$

$$\boxed{P_m = 891.87 \ KN/m^2}$$

$$Q_S = mC_p (T_3 - T_2)$$

$$= 1 \times 1.005 (2045.04 - 800.77)$$

$$\boxed{Q_S = 1250.49 \ kJ/kg}$$

$$Q_R = mC_v (T_4 - T_1)$$

$$= 1 \times 0.718 (1074.27 - 290)$$

$$\boxed{Q_R = 563.10 \ kJ/kg}$$

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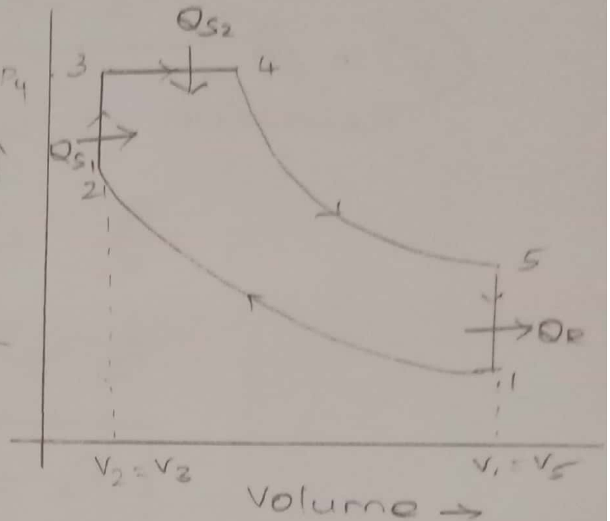
3. In an oil Engine working on dual cycle the heat supplied at constant pressure is twice that the heat at constant volume. The compression and Expansion ratio's are 8 and 5.3. The pressure and Temperature at the begining of cycle are 0.93 bar and 27°C. Find the efficiency of the cycle and mean effective pressure. Take $C_p = 1.005$ kJ/kg k and $C_v = 0.718$ kJ/kg k. Also Find workdone

Given Data:-

$Q_{S_2} = 2Q_{S_1}$



Compression ratio $r = 8$ $\frac{V_1}{V_2}$

Expansion ratio, $\frac{V_5}{V_4} = 5.3 = \frac{V_1}{V_4}$

$P_1 = 0.93$ bar

$= 0.93 \times 10^2$ kN/m²

$T_1 = 27°C$

$= 300$ K

$C_p = 1.005$ kJ/kg k

$C_v = 0.718$ kJ/kg k.

To Find

η_{dual}, P_m

Solution

$$\eta_{dual} = 1 - \frac{1}{r^{\gamma-1}} \left[\frac{k\rho^{\gamma} - 1}{(k-1) + \gamma k(\rho - 1)} \right]$$

$P_1 V_1 = mRT_1$

$$V_1 = \frac{1 \times 0.287 \times 300}{0.93 \times 10^2}$$

$$\boxed{V_1 = 0.925 \, m^3}$$

$$r = \frac{V_1}{V_2}$$

$$V_2 = \frac{0.925}{8}$$

$$\boxed{V_2 = 0.115 \, m^3}$$

Relation b/w pressure and volume

$$\frac{P_2}{P_1} = \left(\frac{V_1}{V_2}\right)^{\gamma}$$

$$P_2 = 0.93 \times 10^2 (8)^{1.4}$$

$$\boxed{P_2 = 1709.26 \, kN/m^2}$$

Relation b/w Temperature and volume

$$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma - 1}$$

$$T_2 = 300 (8)^{1.4 - 1}$$

$$\boxed{T_2 = 689.21 \, k}$$

Process 2-3

$$\frac{P_2 V_2}{T_2} = \frac{P_3 V_3}{T_3} \qquad (V_2 = V_3)$$

$$\frac{P_2}{T_2} = \frac{P_3}{T_3}$$

$$\frac{P_3}{P_2} = \frac{T_3}{T_2}$$

Process 3-4

$$\frac{\cancel{P_3} V_3}{T_3} = \frac{\cancel{P_4} V_4}{T_4} \qquad (P_3 = P_4)$$

$$\frac{V_3}{T_3} = \frac{V_4}{T_4}$$

$$\frac{V_1}{V_4} = 5.3$$

$$V_4 = \frac{0.925}{5.3}$$

$$\boxed{V_4 = 0.174 \ m^3}$$

$$T_4 = \frac{V_4}{V_3} \times T_3 = \frac{0.174}{0.115} T_3$$

$$T_4 = 1.513 T_3$$

Gn $\quad 2 Q_{S2} = Q_{S1}$

$$2 \dot{m} C_p (T_4 - T_3) = 2\dot{m} C_v (T_3 - T_2)$$

$$\frac{1}{2}\frac{C_p}{C_v} = \frac{T_3 - T_2}{T_4 - T_3}$$

$$\frac{1}{2} \times \frac{1.005}{0.718} = \frac{T_3 - 689.21}{1.513\,T_3 - T_3}$$

$$0.7 = \frac{T_3 - 689.21}{0.513\,T_3}$$

$$\cancel{1.43\,T_3 = T_3 - 689.21}$$

$$0.359\,T_3 = T_3 - 689.21$$

$$-0.64\,T_3 = -689.21$$

$$\boxed{T_3 = 1076.89\ k}$$

$$T_4 = 1.513\,T_3$$

$$= 1.513 \times 1076.89$$

$$\boxed{T_4 = 1629.33\ k}$$

$$P_3 = \frac{1076.89}{689.21} \times 1709.26$$

$$\boxed{P_3 = 2670.71\ kN/m^2}$$

$$k = \frac{P_3}{P_2} = \frac{2670.71}{1709.26}$$

$$\boxed{k = 1.56}$$

$$\rho = \frac{V_4}{V_3} = \frac{0.174}{0.115}$$

$$\rho = 1.5$$

$$\eta_{dual} = 1 - \frac{1}{(8)^{1.4-1}}\left[\frac{1.56\,(1.51)^{1.4} - 1}{(1.56-1)+(1.4)(1.56)(1.51-1)}\right]$$

$$\boxed{\eta_{dual} = 54.85\%}$$

$$P_m = P_1 r^{\gamma}\frac{\left[k\gamma(\rho-1)+(k-1)-r^{1-\gamma}(k\rho^{\gamma}-1)\right]}{(\gamma-1)(r-1)}$$

$$= \frac{0.93\times10^{2}\times 8^{1.4}\left[(1.56)(1.4)(1.51-1)+(1.56-1)-8^{1-1.4}(1.56(1.51)^{1.4}-1)\right]}{(1.4-1)(8-1)}$$

$$\boxed{\cancel{P_m = 1560.55\ kN/m^2}}$$

$$\boxed{P_m = 557.33\ kN/m^2}$$

Workdone $= Q_S - Q_R$

$Q_S = Q_{S1} + Q_{S2}$

$Q_{S1} = mC_v(T_3 - T_2)$

$= 1\times0.718(1076.89 - 689.21)$

$= 278.35\ kJ/kg$

$Q_{S1} = mC_p(T_4 - T_3)$

$= 1\times1.005(1629.33 - 1076.89)$

$= 555.20\ kJ/kg$

$Q_S = 833.55\ kJ/kg$

$Q_R = mc_v(T_5 - T_4)$

Process 4-5

$$\frac{T_5}{T_4} = \left(\frac{V_4}{V_5}\right)^{\gamma-1}$$

$$T_5 = 1629.33\left(\frac{1}{5.3}\right)^{1.4-1}$$

$$\boxed{T_5 = 836.17\ K}$$

$$\cancel{Q_R = 1 \times 0.718\,(-836.17 + 1629.33)}$$

$$\cancel{= 569.48\ kJ/kg}$$

$$Q_R = 1 \times 0.718\,(836.17 - 300)$$

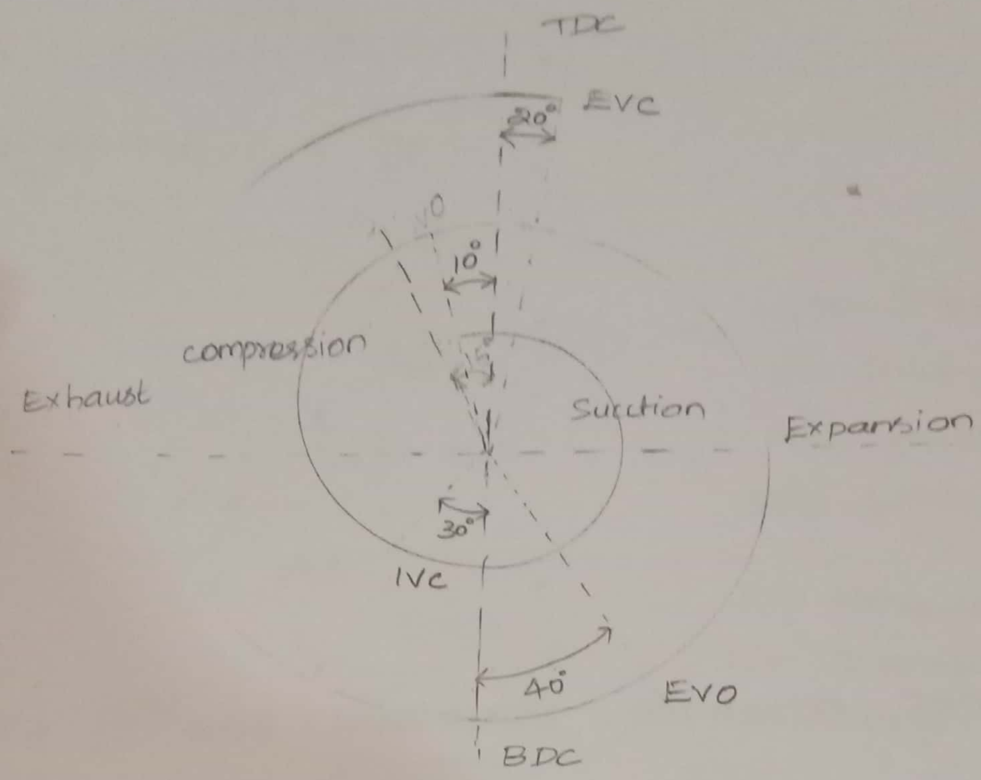
$$= 384.97\ kJ/kg$$

$$W = Q_S - Q_R$$

$$= 833.55 - 384.97$$

$$\boxed{W = 448.58\ kJ/kg}$$

VALVE TIMING DIAGRAM: FOR 4 STROKE CYCLE SI ENGINE:



IVO – Inlet valve open

IVC – Inlet valve closes

IS – Ignition start

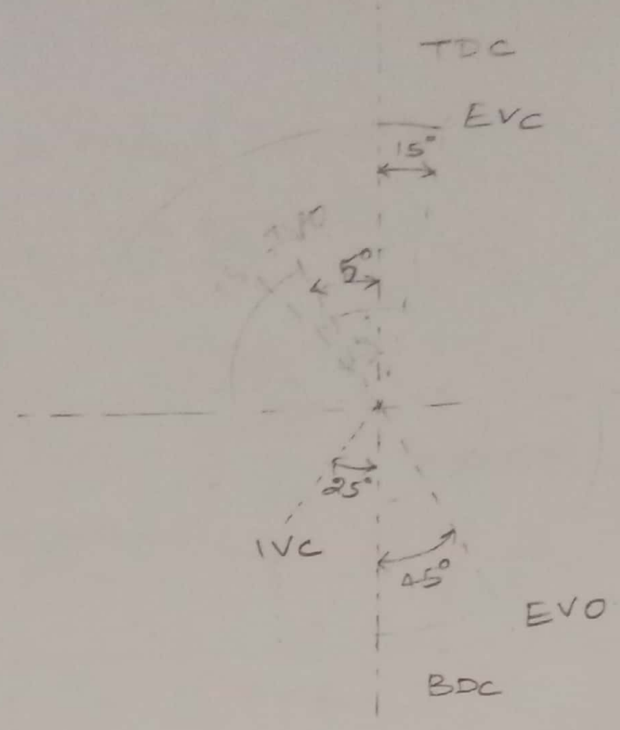
EVO – Exhaust valve open

EVC – Exhaust valve closes

TDC – Top dead centre

BDC – Bottom dead centre.

CI ENGINE :-



PORT TIMING DIAGRAM FOR SI ENGINE :

IPC - Inlet port close

EPO - Exhaust port open

TPO - Transfer port open

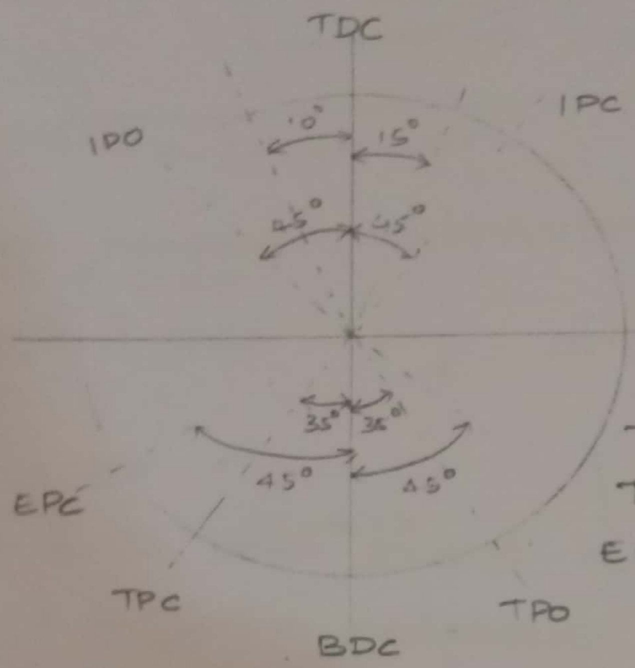
TPC - Transfer port close

EPC - Exhaust port close

IPO - Inlet port open

IS - Ignition start.

CI ENGINE:-



IPO - Inlet port open

IPC - Inlet port close

IG - Ignition starts

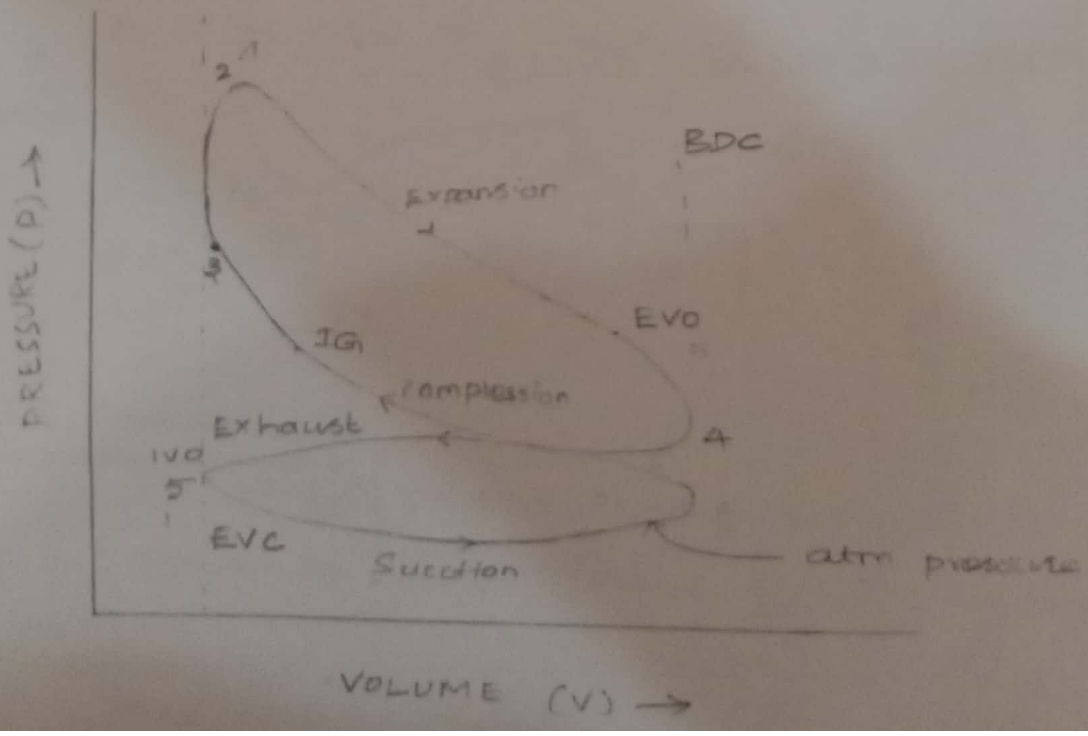
EPC - Exhaust port close

EPO - Exhaust port open

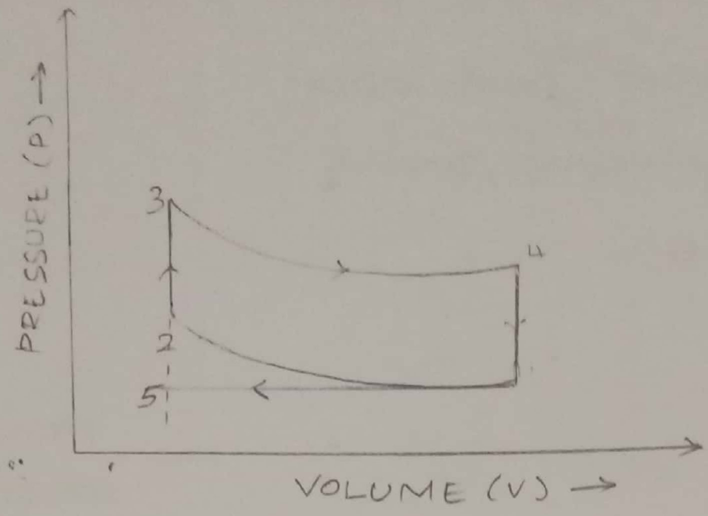
TPO - Transfer port open

TPC - Transfer port close

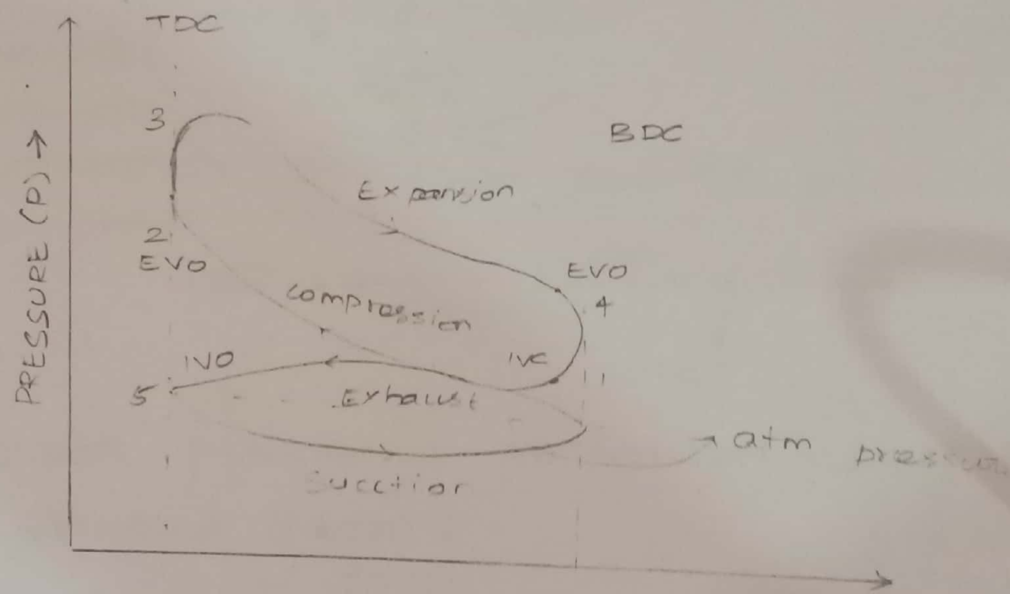
ACTUAL INDICATOR DIAGRAM FOR A ~~TWO~~ FOUR STROKE ENGINE (SI)



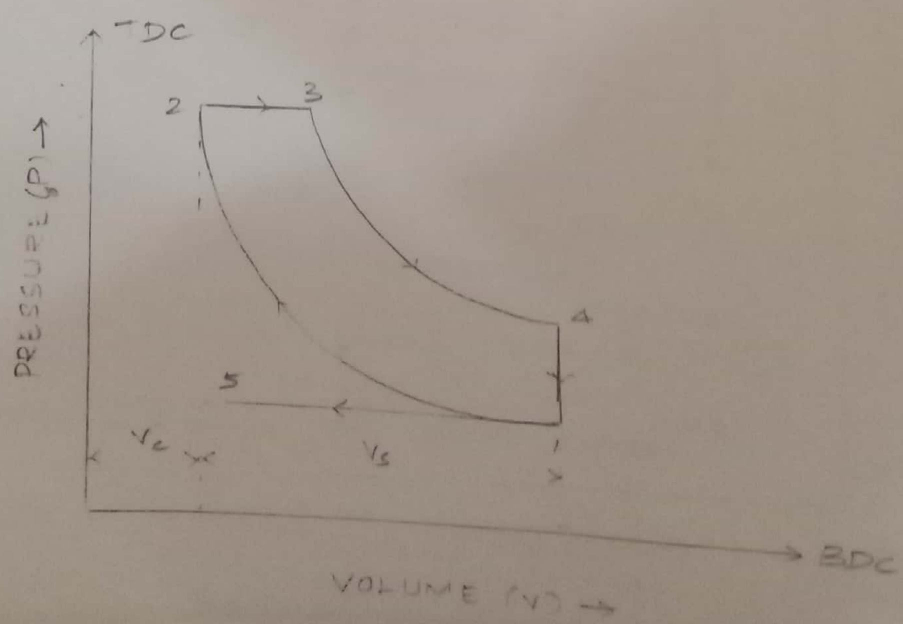
THEORETICAL CYCLE :-



ACTUAL INDICATOR DIAGRAM FOR FOUR STR[OKE]
CI ENGIN[E]



THEORETICAL CYCLE :-



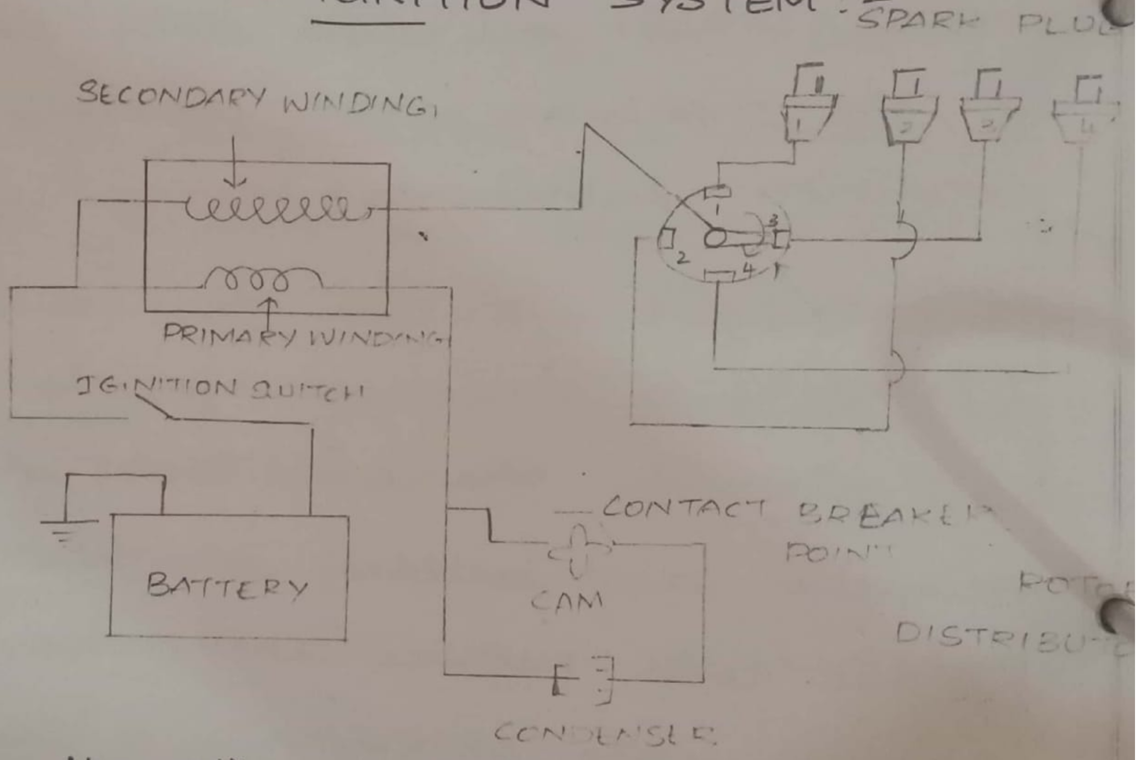
UNIT - II

PETROL ENGINE

IGNITION SYSTEM :-

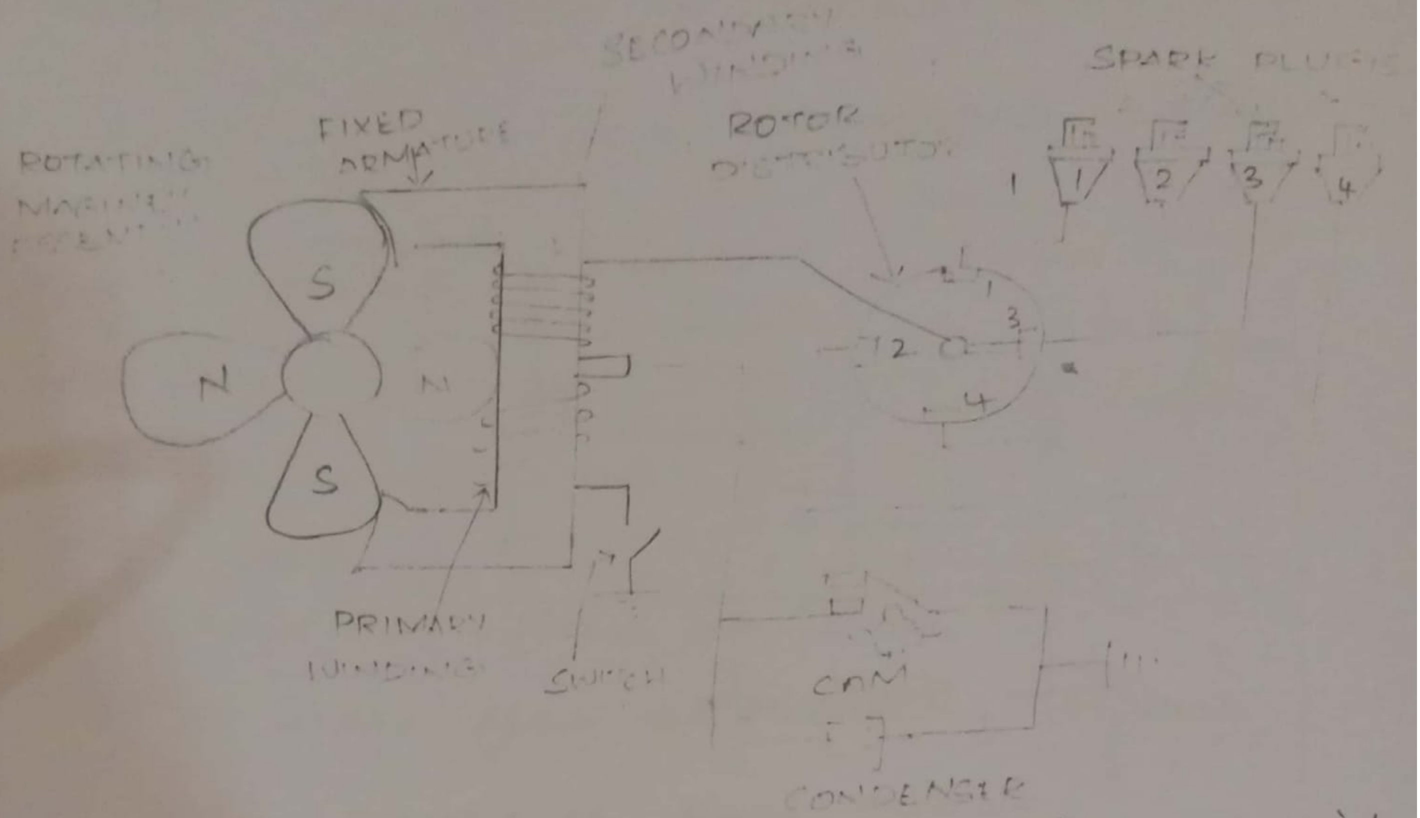
* Battery coil Ignition system
* Magneto ignition system.
* Electric ignition system.
*

1) BATTERY COIL IGNITION SYSTEM :-



Here the Battery is the main source for the spark generation. This battery is rechargeable and derives energy for its recharging from an alternation. ~~It consist of~~ Battery coil ignition system consist of Primary and secondary windings, Battery, cam, condenser, contact Breaker and Rotor distributor.

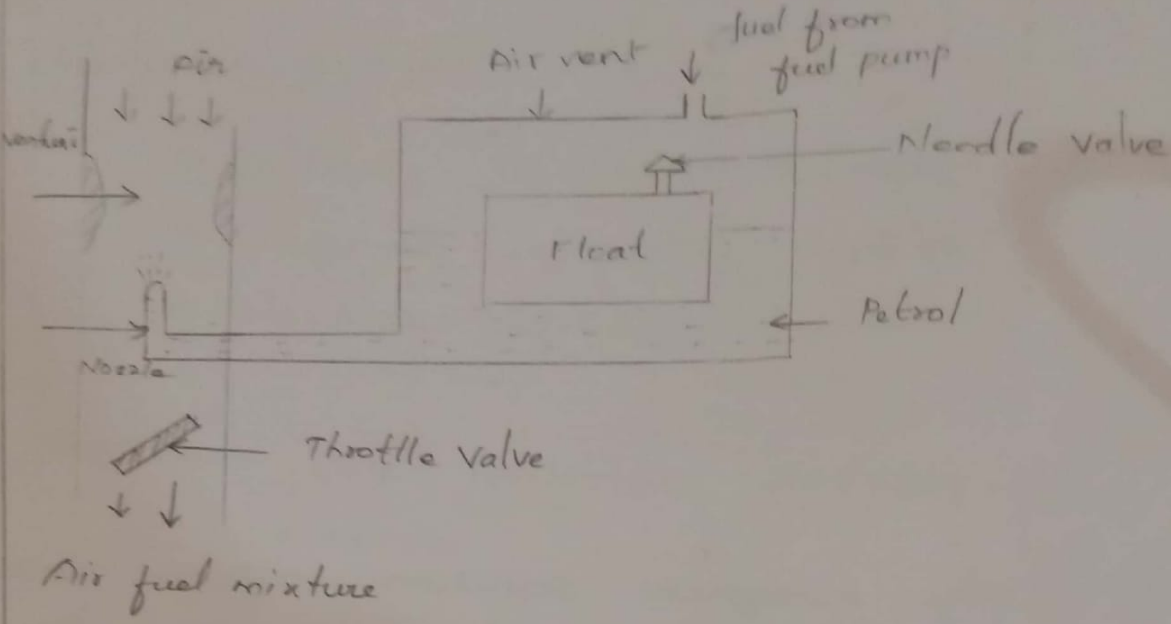
ii) MAGNETO IGNITION SYSTEM: —



The magneto ignition system consists of Magneto, Distributor, Spark plug, Rotor distributor cam, windings.

Here the Battery is replaced by a magnet and has a fixed armature in which the primary and secondary winding are mounted. The secondary winding is connected to the rotor distributor to ~~spar~~ ignite the spark plug in a correct sequential firing order.

SIMPLE CARBURETTOR: -



Function of carburettor: -

*. It maintain a small resin of petrol in the float chamber.

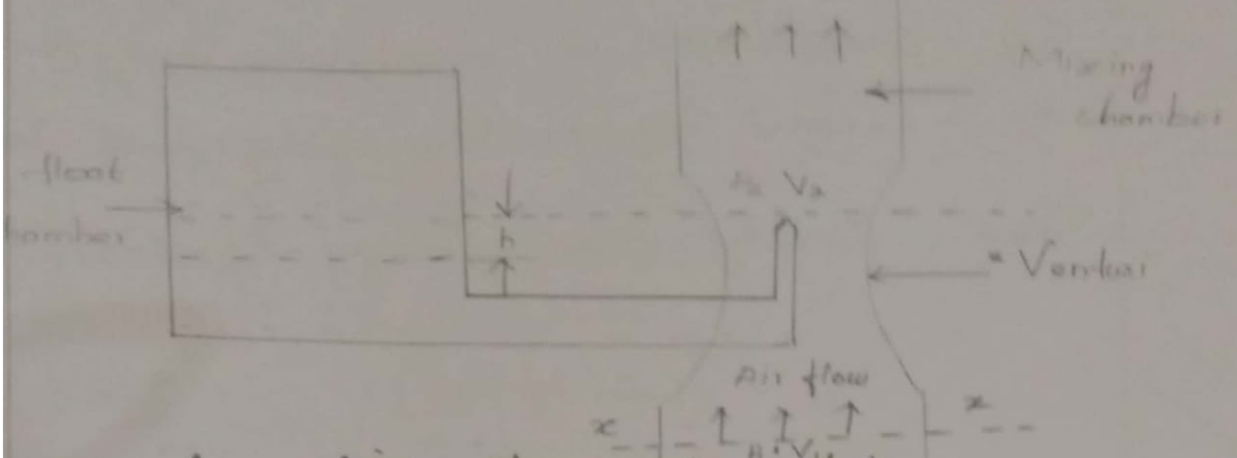
* It Atomizes and vapourises the fuel.

* It prepares a mixture of petrol and air in correct proportion.

* It supplies a fine spray of Petrol

*. It produces a homogeneous mixture.

DESIGN CALCULATION IN CARBURETTOR'S :-



A_1 – Air flow at inlet

A_2 – Air flow at ventury throat

A_f – Area of fuel nozzle

V_f – velocity of fuel at discharge from nozzle.

M_a – mass Flow of air.

M_f – mass flow of fuel

P_1 – Pressure of air at inlet

P_2 – Pressure of air at throat.

h_1 – specific enthalpy of air at inlet.

h_2 – Specific enthalpy of air at throat.

T_1 – Absolute Temperature of air at inlet

T_2 – Absolute Temperature of air at venturi throat.

ρ – Density of air

ρ_f – Density of fuel.

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C_{da} - Coefficient of discharge of venturi

C_{df} - Coefficient of discharge for fuel ori

h - height of nozzle above fuel level.

problem on derivation

From steady flow energy Equation (Nozzle

$$V_2 = \sqrt{2(h_1 - h_2)}$$

$$V_2 = \sqrt{2C_p(T_1 - T_2)} \qquad \bigg| \quad h = C_pT$$

$$V_2 = \sqrt{2C_pT_1\left(1 - \frac{T_2}{T_1}\right)}$$

This flow isentrophic flow

Relation between Pressure and Temperatu

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}$$

$$V_2 = \sqrt{2C_pT_1\left[1 - \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}\right]}$$

consider the coefficient velocity

$$V_2 = C_v\sqrt{2C_pT_1\left[1 - \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}\right]}$$

Isentrophic flow

$$Pv^{\gamma} = C$$

$$P_1 v_1^{\gamma} = P_2 v_2^{\gamma}$$

$$\frac{P_2}{P_1} = \frac{v_1^{\gamma}}{v_2^{\gamma}}$$

$$\frac{P_2}{P_1} = \left(\frac{v_1}{v_2}\right)^{\gamma}$$

$$\frac{v_1}{v_2} = \left(\frac{P_2}{P_1}\right)^{1/\gamma}$$

$$v_2 = \frac{v_1}{\left(\frac{P_2}{P_1}\right)^{1/\gamma}}$$

$$v_2 = v_1\left(\frac{P_2}{P_1}\right)^{-1/\gamma}$$

Using gas Equation

mass = 1 kg

$$P_1 v_1 = mRT_1$$

$$v_1 = \frac{mRT_1}{P_1}$$

$$v_1 = \frac{RT_1}{P_1}$$

$$\frac{A_1 V_1}{v_1} \quad \frac{A_2 V_2}{v_2}$$

$$\boxed{v_2 = \frac{RT_1}{P_1}\left(\frac{P_2}{P_1}\right)^{-1/\gamma}}$$

W.K.T

Mass flow rate

$$M_a = \frac{A_1 V_1}{v_1} = \frac{A_2 V_2}{v_2}$$

$$\dot{m}_a = \frac{A_2 V_2}{v_2}$$

$$\dot{m}_a = \frac{A_2 C_v \sqrt{2 C_p T_1 \left[1 - \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}\right]}}{\frac{R T_1}{P_1} \left(\frac{P_2}{P_1}\right)^{-1/\gamma}}$$

$$\dot{m}_a = \frac{A_2 P_1 C_v}{R T_1} \left(\frac{P_2}{P_1}\right)^{1/\gamma} \sqrt{2 C_p T_1 \left[1 - \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}\right]}$$

$$\dot{m}_a = \frac{A_2 P_1 C_v}{R T_1} \sqrt{\left(\frac{P_2}{P_1}\right)^{2/\gamma} 2 C_p T_1 \left[1 - \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}\right]}$$

$$= \frac{A_2 P_1 C_v}{R T_1} \sqrt{2 C_p T_1 \left[\left(\frac{P_2}{P_1}\right)^{\frac{2}{\gamma}} - \left(\frac{P_2}{P_1}\right)^{\frac{2}{\gamma}} \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}\right]}$$

$$= \frac{A_2 P_1 C_v}{R T_1} \sqrt{2 C_p T_1 \left[\left(\frac{P_2}{P_1}\right)^{\frac{2}{\gamma}} - \left(\frac{P_2}{P_1}\right)^{\frac{\gamma+1}{\gamma}}\right]}$$

$$= \frac{A_2 P_1 C_v \sqrt{T_1}}{R T_1} \sqrt{2 C_p \left[\left(\frac{P_2}{P_1}\right)^{2/\gamma} - \left(\frac{P_2}{P_1}\right)^{\frac{\gamma+1}{\gamma}}\right]}$$

$$= \frac{A_2 P_1 C_v \sqrt{T_1}}{R \sqrt{T_1} \sqrt{T_1}} \sqrt{2 C_p \left[\left(\frac{P_2}{P_1}\right)^{\frac{2}{\gamma}} - \left(\frac{P_2}{P_1}\right)^{\frac{\gamma+1}{\gamma}}\right]}$$

$$\frac{2}{\gamma} + \frac{\gamma-1}{\gamma}$$

$$\frac{2+\gamma-1}{\gamma}$$

$$\frac{\gamma+1}{\gamma}$$

$$m_a = \frac{A_2 P_1 C_v}{R\sqrt{T_1}} \sqrt{2 C_p \left[\left(\frac{P_2}{P_1}\right)^{2/\gamma} - \left(\frac{P_2}{P_1}\right)^{\frac{\gamma+1}{\gamma}}\right]}$$

Actual mass flow rate of fuel

$$(m_f)_{actual} = C_{df} A_f \sqrt{2\rho_f (P_1 - P_2 - gh\rho_f)}$$

$$(M_a)_{actual} = C_{da} A_2 \sqrt{2\rho_a (P_1 - P_2)}$$

Air fuel ratio, $\frac{m_a}{m_f}$ $\qquad m_f = A_f C_{df}\sqrt{2\rho_f(P_1-P_2)}$

$$\frac{m_a}{m_f} = \frac{C_{da} A_2}{C_{df} A_f} \sqrt{\frac{\rho_a}{\rho_f}}$$

1. A simple Jet carburator is required to supply 5.5 kg of air per minute and 0.6 kg of fuel per minute. Density of fuel is 750 kg/m³. The air is initially at 1 bar and 30°c. Calculate the throat diameter of the choke for a flow velocity of 95 m/s. The velocity coefficient is taken as 0.78.

If the pressure drop across the

fuel metring orifice is 0.76 of that at choke. Calculate the orifice diameter assuming $C_{df} = 0.62$

[Pressure drop across metring orifice equal to 0.76 pressure drop at venturi

Given Data:-

$m_a = 5.5 \text{ kg/min}$

$= 0.091 \text{ kg/s}$

$m_f = 0.6 \text{ kg/min}$

$= 0.01 \text{ kg/s}$

$\rho_f = 750 \text{ kg/m}^3$

$P_1 = 1 \text{ bar}$

$= 1 \times 10^5 \text{ N/m}^2$

$T_1 = 30^\circ C$

$= 303 \text{ K}$

$C_{df} = 0.62$

$C_v = 0.78$

$V_2 = 95 \text{ m/s}$

To Find:-

d_2

d_f

Solution:-

$$m_a = \frac{A_2 V_2}{v_2}$$

$$V_2 = C_V \sqrt{2 C_p T_1 \left[1 - \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}\right]}$$

$$95 = 0.78 \sqrt{2 \times 1.005 \times 10^3 \times 303 \left[1 - \left(\frac{P_2}{1 \times 10^5}\right)^{\frac{0.4}{1.4}}\right]}$$

$$\frac{95}{0.78} = \sqrt{609.03 \times 10^3 \left[1 - \left(\frac{P_2}{1 \times 10^5}\right)^{\frac{0.4}{1.4}}\right]}$$

$$14.83 \times 10^3 = 609.03 \times 10^3 \left[1 - \left(\frac{P_2}{1 \times 10^5}\right)^{0.285}\right]$$

$$0.024 = 1 - \frac{P_2^{0.285}}{(1 \times 10^5)^{0.285}}$$

$$P_2^{0.285} = 0.97 \times (1 \times 10^5)^{0.285}$$

$$\boxed{P_2 = 89.86 \times 10^3 \ N/m^2}$$

$$v_2 = \frac{R T_1}{P_1} \left(\frac{P_2}{P_1}\right)^{\frac{-1}{\gamma}}$$

$$= \frac{0.286 \times 10^3 \times 303}{1 \times 10^5} \left(\frac{89.86 \times 10^3}{1 \times 10^5}\right)^{\frac{-1}{1.4}}$$

$$v_2 = 0.866 \times (0.898)^{-0.718}$$

$$\boxed{v_2 = 0.935 \ m^3/kg}$$

$$0.091 = \frac{A_2 \times 95}{0.935}$$

$$\boxed{A_2 = 8.95 \times 10^{-4} \ m^2}$$

$$\frac{\pi}{4} d_2^2 = 8.95 \times 10^{-4}$$

$$\boxed{d_2 = 0.0337 \quad m}$$

$$m_f = A_f C d_f \sqrt{2 \rho_f (P_1 - P_2)}$$ pressure drop

$$P_1 - P_2 = (1 \times 10^5) - (89.86 \times 10^3)$$

$$= 10140 \times 0.76$$

$$= 7.706 \times 10^3$$

$$0.01 = A_f \, 0.62 \sqrt{2 \times 750 \times 7.706 \times 10}$$

$$A_f = 4.74 \times 10^{-6} \; m^2$$

$$\frac{\pi}{4} d_f^2 = 4.74 \times 10^{-6}$$

$$\boxed{d_f = 2.45 \times 10^{-3} \; m^2}$$

2. Determine the size of fuel orifice to give 13:1 air fuel ratio. If the venturi throat has a 32mm diamet and the pressure drop in the venturi is 0.07 bar. The air pressur and temperature of carburettor entrance are 1 bar, 27°C respectively

The fuel orifice is at the same level as that of the float chamber. Take density of gasoline as $740 kg/m^3$. and discharge coefficient as unity.

Given Data:-

$d_2 = 32 mm$

$= 32 \times 10^{-3} m$

$P_1 - P_2 = 0.07$ bar

$= 0.07 \times 10^5 N/m^2$

$P_1 = 1$ bar

$= 1 \times 10^5 N/m^2$

$T_1 = 27°c$

$= 300 k$

$\rho_f = 740 kg/m^3$

$\frac{m_a}{m_f} = \frac{13}{1}$

To find d_f

$Cd_f = 1.$

Solution:-

$m_f = A_f Cd_f \sqrt{2 \rho_f (P_1 - P_2)}$

$m_a = \frac{A_2 V_2}{v_2}$

$V_2 = \sqrt{2 C_p T_1 \left[1 - \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}\right]}$

$P_1 - P_2 = 0.07 \times 10^5$

$1 \times 10^5 - 0.07 \times 10^5 = P_2$

$$P_2 = 93 \times 10^3 \ N/m^2$$

$$V_2 = \sqrt{2 \times 1.005 \times 10^3 \left[1 - \left(\frac{93 \times 10^3}{1 \times 10^5}\right)^{\left(\frac{1.4-1}{1.4}\right)}\right]}$$

$$\boxed{V_2 = 111.295 \ m/s}$$

$$v_2 = \frac{RT_1}{P_1} \left(\frac{P_2}{P_1}\right)^{-1/\gamma}$$

$$= \frac{0.287 \times 10^3 \times 300}{1 \times 10^5} \left(\frac{93 \times 10^3}{1 \times 10^5}\right)^{\frac{-1}{1.4}}$$

$$\boxed{v_2 = 0.90 \ m^3/kg}$$

$$A_2 = \frac{\pi}{4} d^2 = \frac{\pi}{4} (32 \times 10^{-3})^2$$

$$A_2 = 8.04 \times 10^{-4} \ m^2$$

$$m_a = \frac{8.04 \times 10^{-4} \times 111.295}{0.9}$$

$$\boxed{m_a = 0.09 \ kg}$$

$$\frac{m_a}{m_f} = 13$$

$$m_f = 6.9 \times 10^{-3} \ kg.$$

$$6.9 \times 10^{-3} = \frac{\pi}{4} d_f^2 \times 1 \sqrt{2 \times 740 \times 0.07 \times 10^5}$$

$$= 2527.95\, d_f^2$$

$$\boxed{d_f = 1.65 \times 10^{-3}\ m.}$$

Q3. The throat diameter of a carburettor is 80mm and nozzle diameter is 6mm. The C_{da} is 0.85 and $C_{df} = 0.7$. The nozzle lip is 6 mm. The pressure difference casing the flow is 0.1 bar. Find a) Air fuel ratio supplied by the carburettor neglecting nozzle lip. b) Air fuel ratio considering nozzle lip and c) The maximum velocity of air required to start the fuel flow neglecting air compressibility. Take density of air is $1.2\ kg/m^3$ and density of fuel $750 kg/m^3$.

Given Data:-

$d_2 = 80\ mm$

$= 0.08\ m$

$d_f = 6mm$

$= 0.006\ m.$

$C_{da} = 0.85$

$C_{df} = 0.7$

$h = 6\,mm$

$= 0.006\,m.$

$P_1 - P_2 = 0.1\,bar$

$= 0.1 \times 10^5\,N/m^2$

$\rho_a = 1.2\,kg/m^3$

$\rho_f = 750\,Kg/m^3$

To Find

i) $\frac{m_a}{m_f}$ (neglecting nozzle lip)

ii) $\frac{m_a}{m_f}$ (considering nozzle lip).

iii) maximum velocity.

Solution.

i) Neglecting nozzle lip.

$$\frac{m_a}{m_f} = \frac{C_{da}\,A_2}{C_{df}\,A_f}\sqrt{\frac{\rho_a}{\rho_f}}$$

$$= \frac{0.85 \times (0.08)^2}{0.7 \times (0.006)^2}\sqrt{\frac{1.2}{750}}$$

$$\boxed{\frac{m_a}{m_f} = 8.72}$$

ii) considering nozzle lip.

$$m_a = C_{da} A_2 \sqrt{2 \rho_a (P_1 - P_2)}$$

$$= 0.85 \times \frac{\pi}{4} (0.08)^2 \sqrt{2 \times 1.2 (0.1 \times 10^5}$$

$$m_a = 0.66.$$

$$m_f = C_{df} A_f \sqrt{2 \rho_f (P_1 - P_2 - g h \rho_f)}$$

$$= 0.7 \times \frac{\pi}{4} (0.006)^2 \sqrt{2 \times 750 [0.1 \times 10^5 - (9.81 \times 0.006 \times 750}$$

$$= 0.076$$

$$\frac{m_a}{m_f} = \frac{0.66}{0.076}$$

$$\boxed{\frac{m_a}{m_f} = 8.68}$$

iii) maximum velocity.

$$V_{max} = \sqrt{2gh \frac{\rho_f}{\rho_a}}$$

$$= \sqrt{2 \times 9.81 \times 0.006 \left(\frac{750}{1.2}\right)}$$

~~$V_{max} = 27.12$~~

$$\boxed{V_{max} = 8.57 \text{ m/s}}$$

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Air fuel ratio of a mixture supplied to an engine by a carburettor is 13. The fuel consumption of the engine is 7.5 kg/hr. The diameter of the venturi is 20mm. Find the diameter of the fuel. Nozzle is 4 mm. Take the following data density of fuel 750 kg/m³. coefficient of discharge of air is 0.80, Coefficient of discharge of fuel is 0.7 and atmospheric pressure is 1.013 bar and temperature is 27°

Given Data:-

$$\rho_f = 750 \text{ kg/m}^3$$

$$Cd_a = 0.8$$

$$Cd_f = 0.7$$

$$P_a = 1.013 \text{ bar}$$

$$= 1.013 \times 10^5 \text{ N/m}^2$$

$$T_a = 27°c$$

$$= 300 \text{ k}.$$

$$h = 4 \text{ mm}$$

$$= 0.004 \text{ m}.$$

$$\frac{m_a}{m_f} = 13$$

$$d_2 = 20 \text{ mm} = 0.02 \text{ m}$$

$$m_f = 7.5\ kg/hr$$

$$= \frac{7.5}{3600}$$

$$= 2.08 \times 10^{-3}\ kg/s.$$

To Find:-

d_f

Solution:-

$$m_f = C_{df} A_f \sqrt{2\rho_f (P_1 - P_2 - gh\rho_f)}$$

$$m_a = C_{da} A_2 \sqrt{2\rho_a (P_1 - P_2)}$$

$$P_a V_a = mRT_a$$

$$P_a = \frac{m}{V_a} RT_a \qquad \left(\frac{m}{V} = \rho\right)$$

$$\rho = \frac{P_a}{RT_a}$$

$$= \frac{1.013 \times 10^5}{0.286 \times 10^3 \times 300}$$

$$\rho_a = 1.18\ kg/m^3$$

$$\frac{m_a}{2.08 \times 10^{-3}} = 13$$

$$m_a = 0.027\ kg.$$

$$0.02 = 0.8 \times \frac{\pi}{4} d_2^2 \sqrt{2 \times 1.18 (P_1 - P_2)}$$

$$0.027 = 251.32 \times 10^{-4} \sqrt{2.36 (P_1 - P_2)}$$

$$\cancel{(7.95 \times 10^{-5})^2 = 2.36 (P_1 - P_2)}$$

$$\cancel{P_1 - P_2 = 2.}$$

$$107.44^2 = 2.36 (P_1 - P_2)$$

$$P_1 - P_2 = 4891.25 \ N/m^2.$$

$$2.08 \times 10^{-3} = 0.7 \times \frac{\pi}{4} d_f^2 \sqrt{2 \times 750 (4891.25 - (9.\ldots}$$

0.004 ×

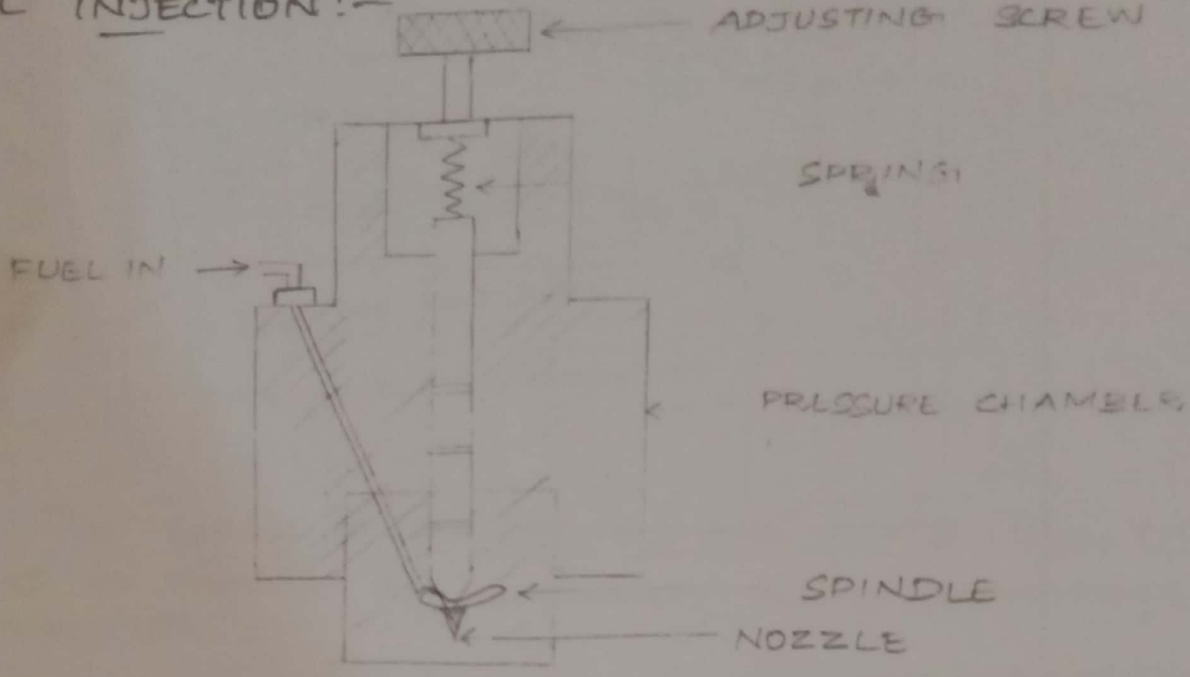
$$2.08 \times 10^{-3} = 1484.68 \ d_f^2$$

$$\boxed{d_f = 1.18 \times 10^{-3} \ m}$$

UNIT-III

DIESEL ENGINE

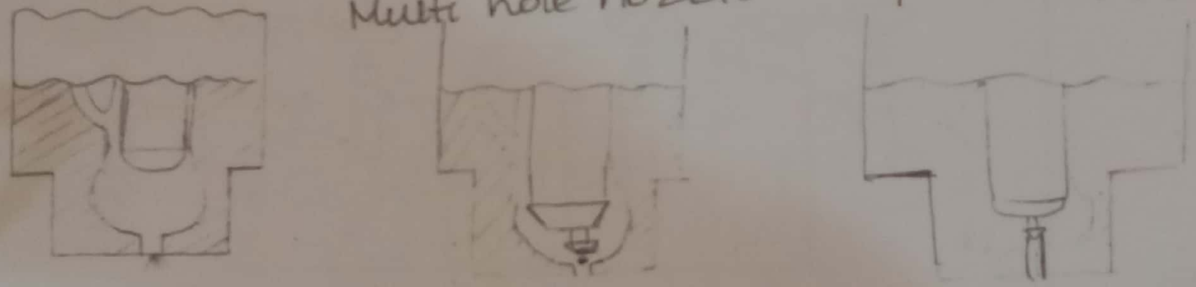
FUEL INJECTION:-



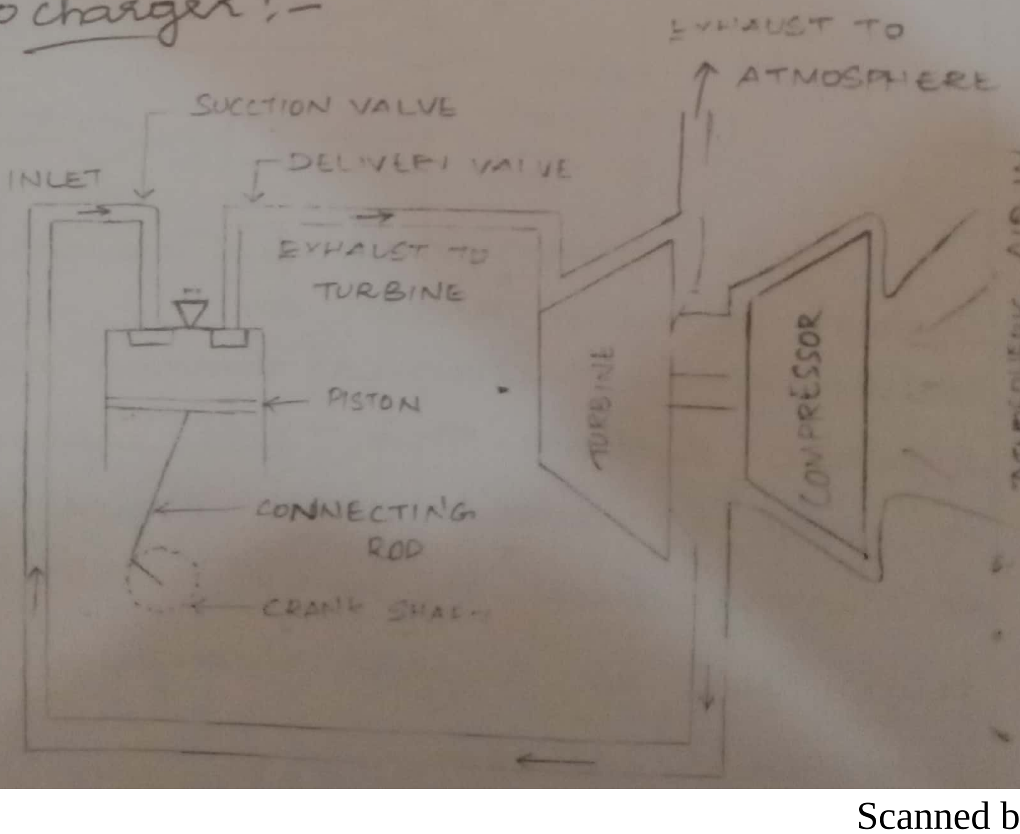
SINGLE HOLE NOZZLE:-

Multi hole nozzle

pindle nozzle



Turbo charger:-



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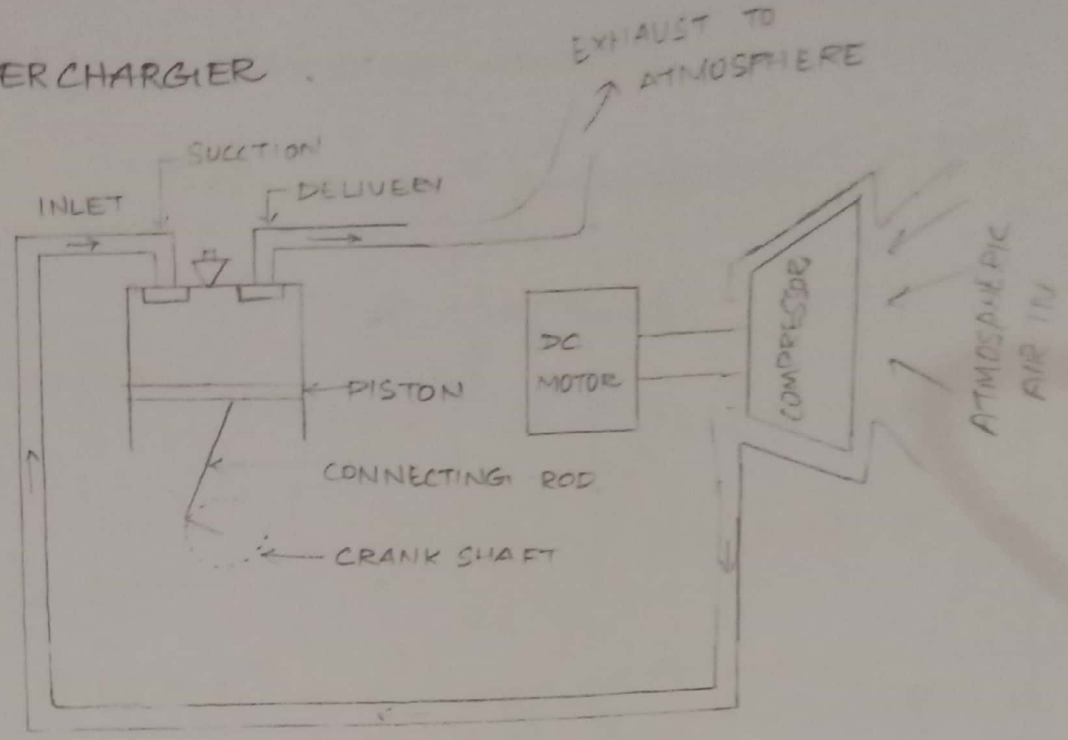
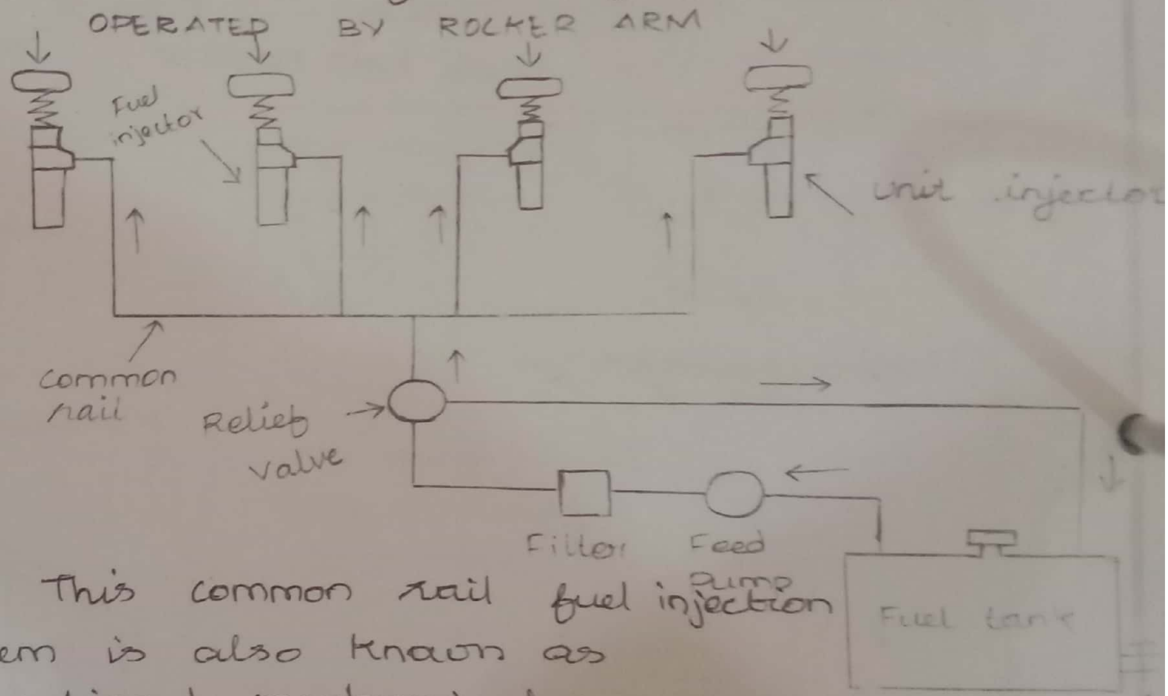
SUPERCHARGER.

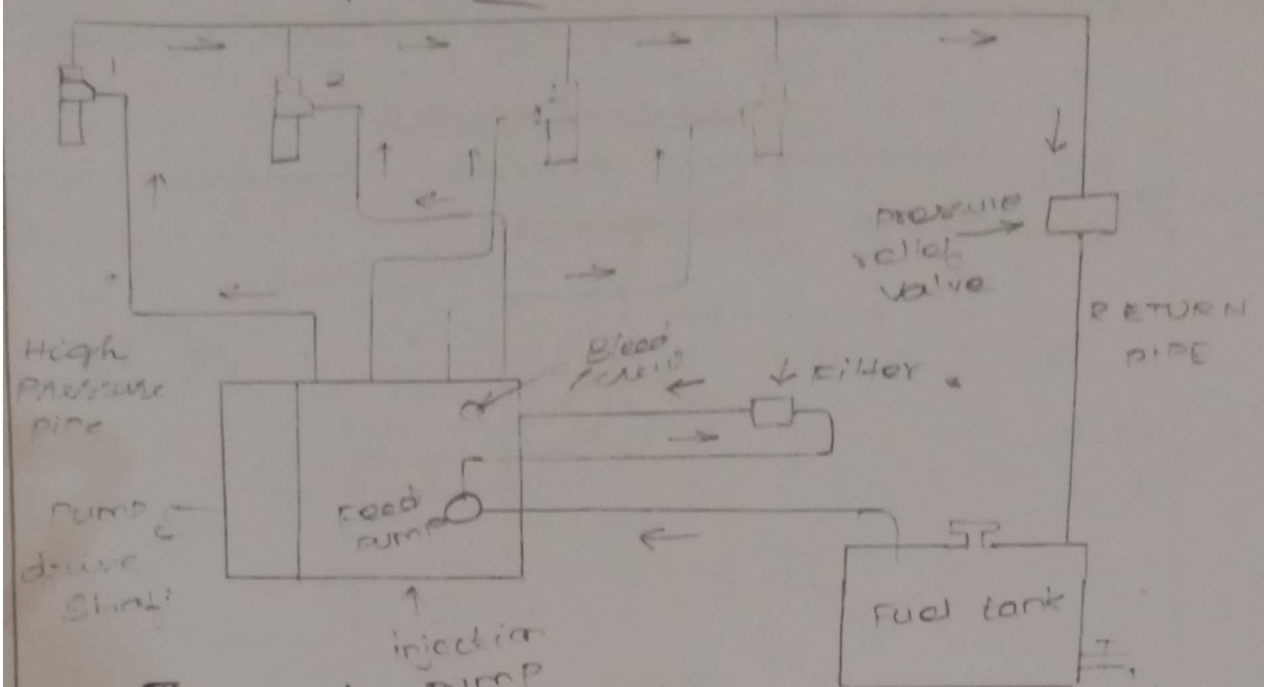


Common Rail fuel injection system.



This common rail fuel injection system is also known as conventional mechanical common rail fuel injection system. This fuel injection System is used in detroit diesel engine which is nam as Jimmy diesel. By using a single injection pump fuel is supplied through unit injector into each cylinder.

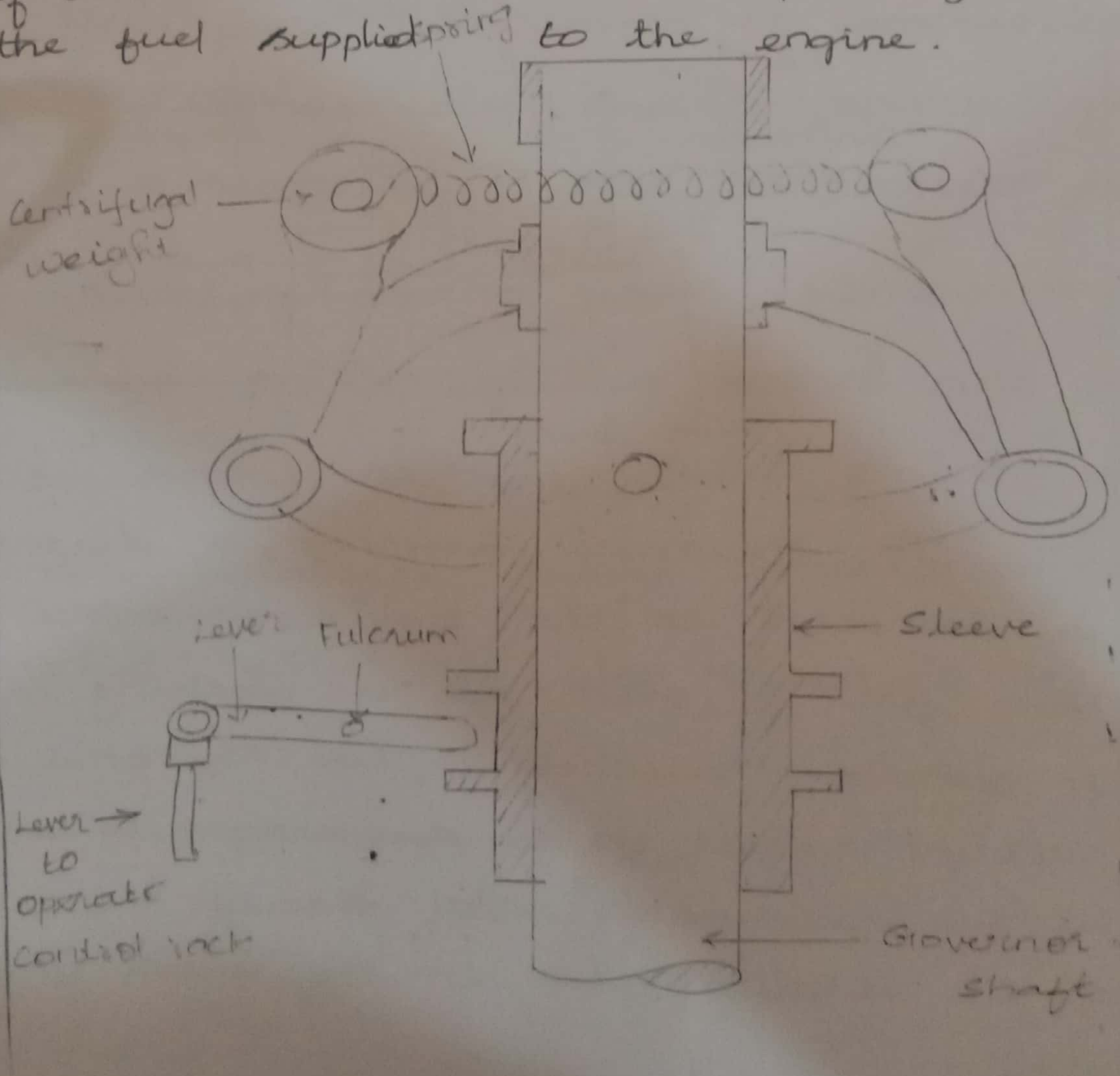
Individual pump fuel injection system



The fuel is pumped by fuel pump. The fuel pump is operated by injection pump camshaft.

Governor :-

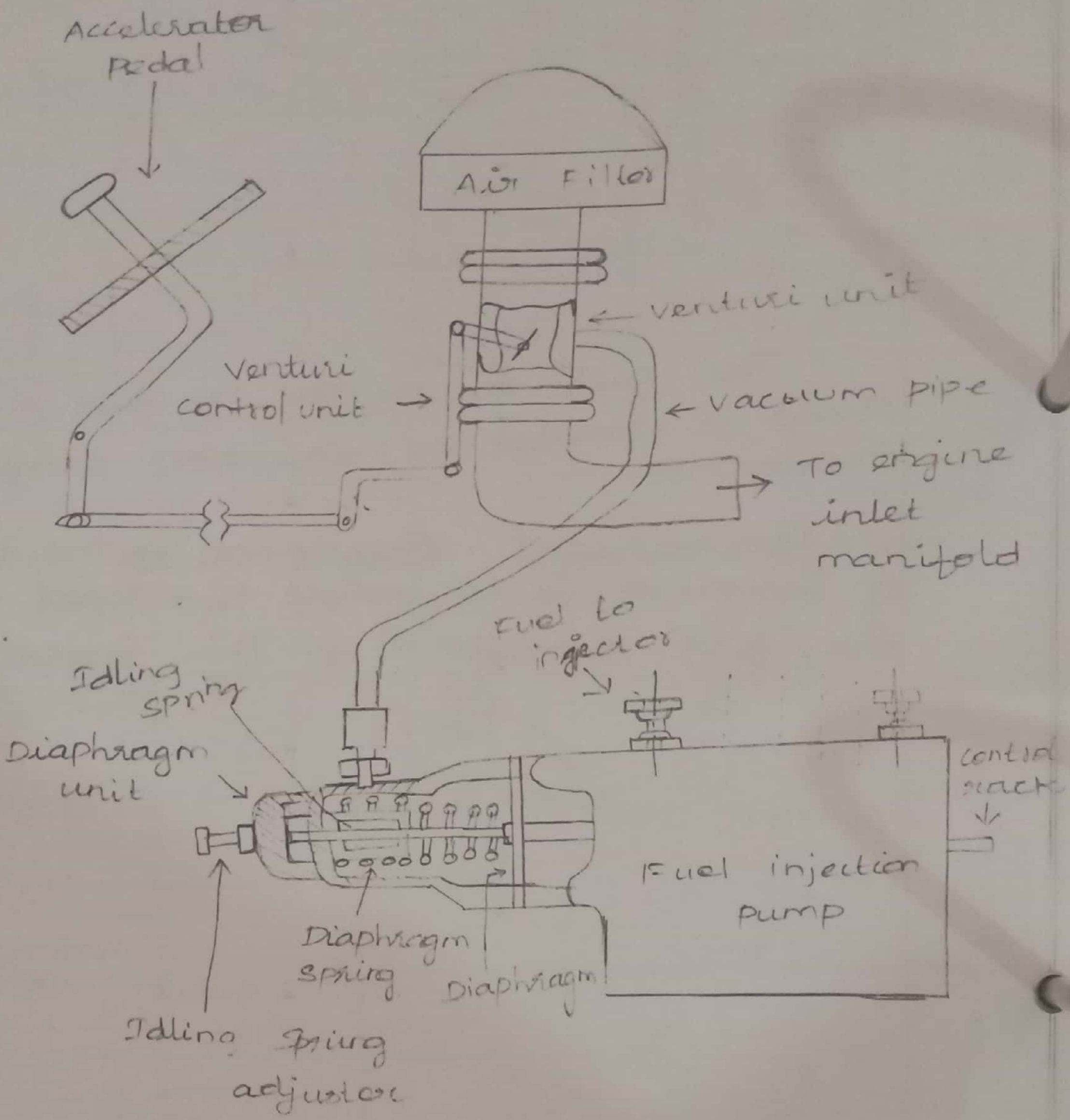
i) Mechanical Governor. → The main principle of Governor is to reduce the speed by reducing the fuel supplied to the engine.



UNIT - III.

DIESEL ENGINE

i) Pneumatic Governor :-

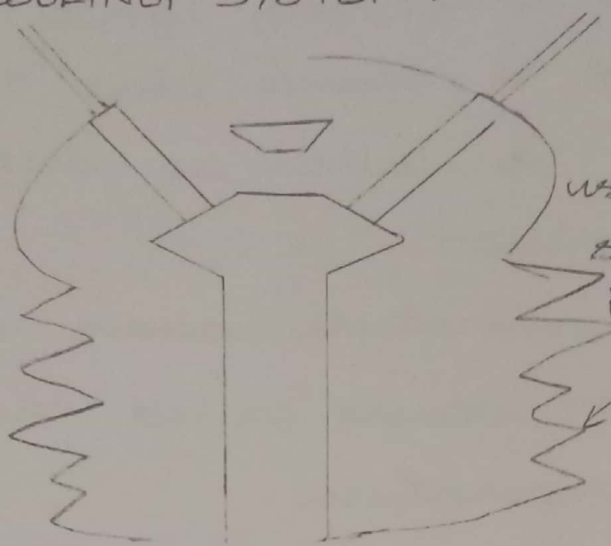


In Pneumatic Governor, a diaphragm is connected to the fuel pump control rack. Here air is used as a working medium to operate the whole system. The amount of vacuum applied to the diaphragm is controlled by the accelerator pedal through the piston of the butterfly valve in the venturi unit.

UNIT - IV

COOLING & LUBRICATION

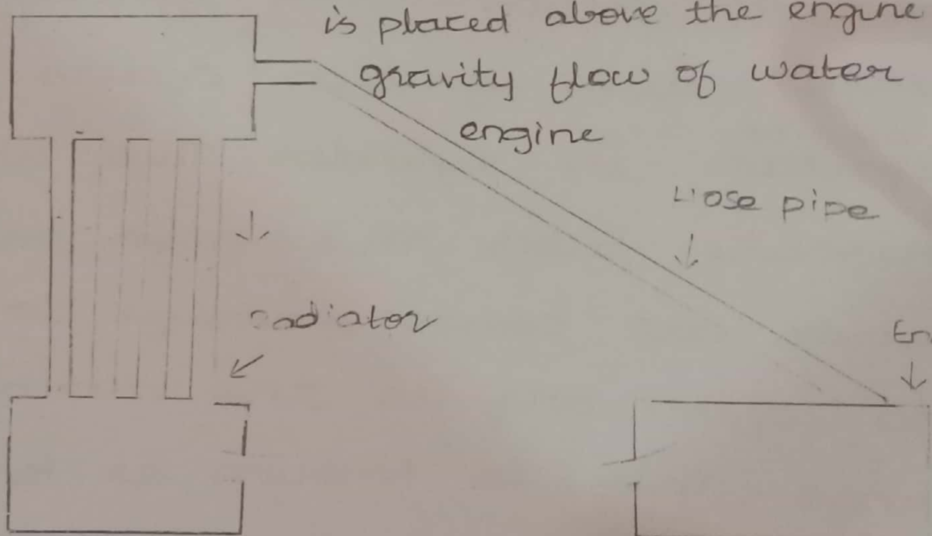
1) AIR COOLING SYSTEM :-



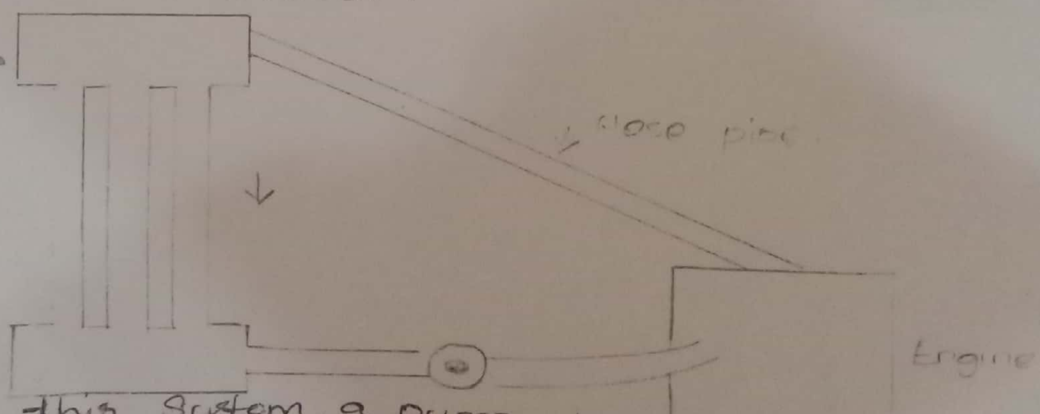
Air cooling system used for small engines such as aircraft en[gines] industrial engines a[nd] agricultural engines

THERMO SYPHON SYSTEM :-

~~water~~. In this system, radia[tor] is placed above the engine for gravity flow of water to the engine

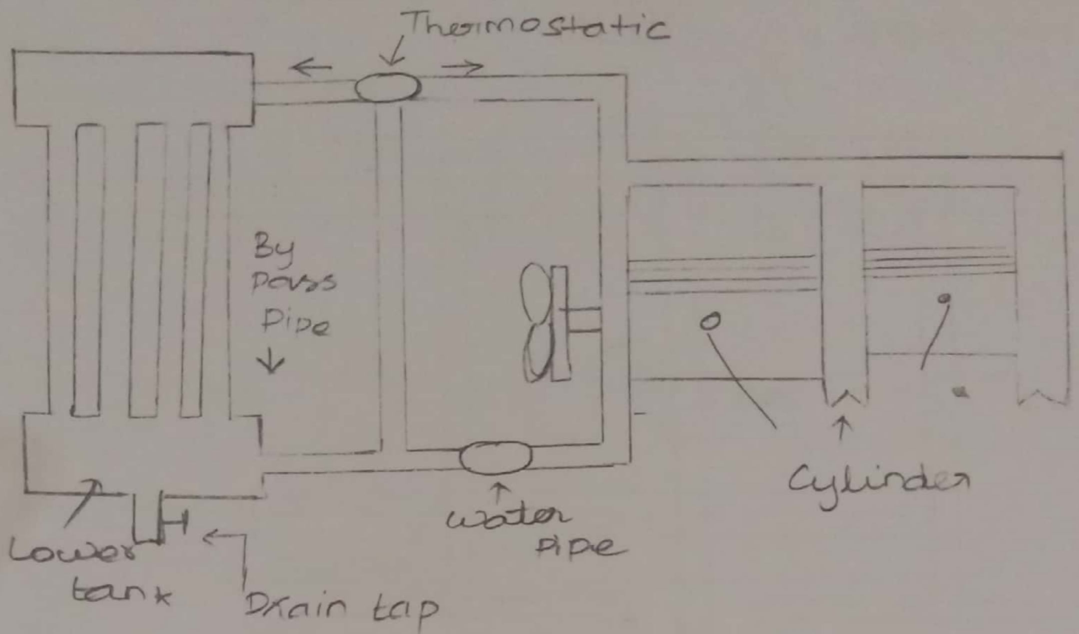


PUMP ~~COOLING~~ CIRCULATION SYSTEM

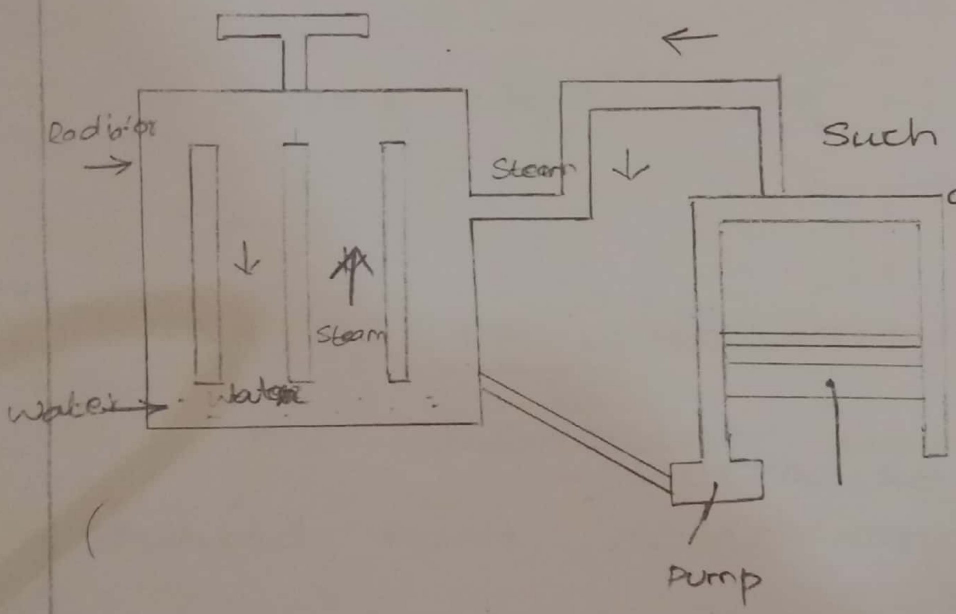


In this system, a pump is used for the positive circulation of water in the water Jacke[t]

WATER COOLING SYSTEM:-



EVAPORATIVE COLLING RADIATOR

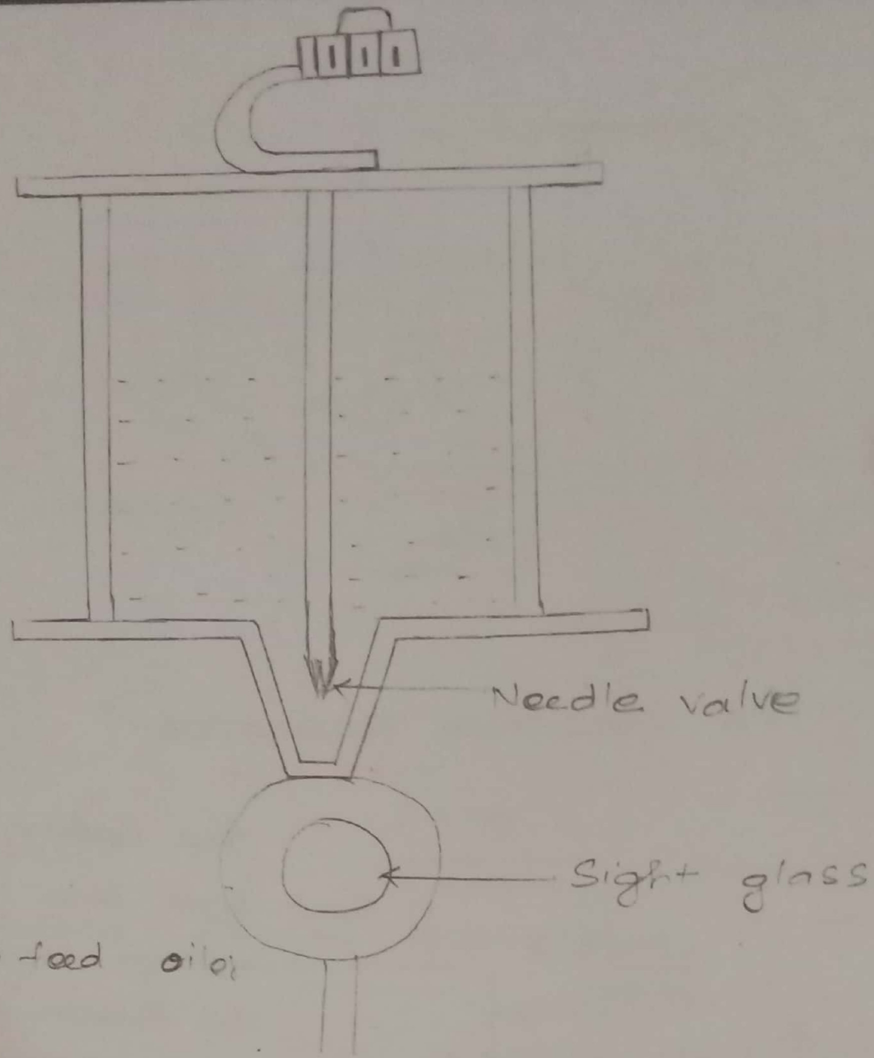


The cooling circuit is such that the coolant is always liquid but the Steam formed is flashed off in a separate vessel.

METHOD OF LUBRICATION :-

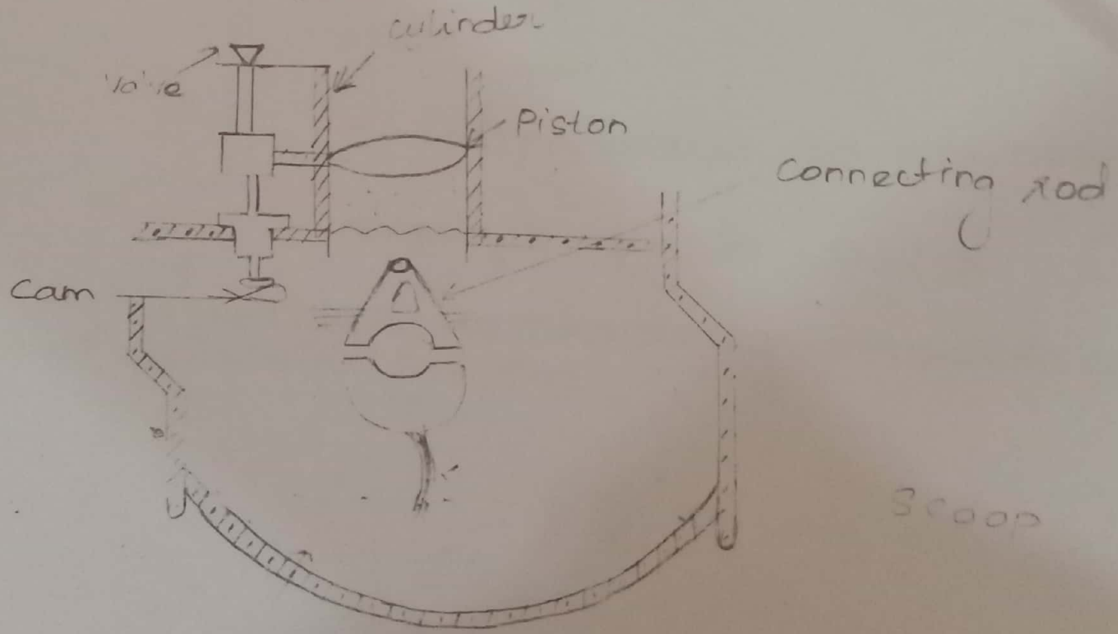
* Wet Sump System

a) GRAVITY LUBRICATION SYSTEM:-



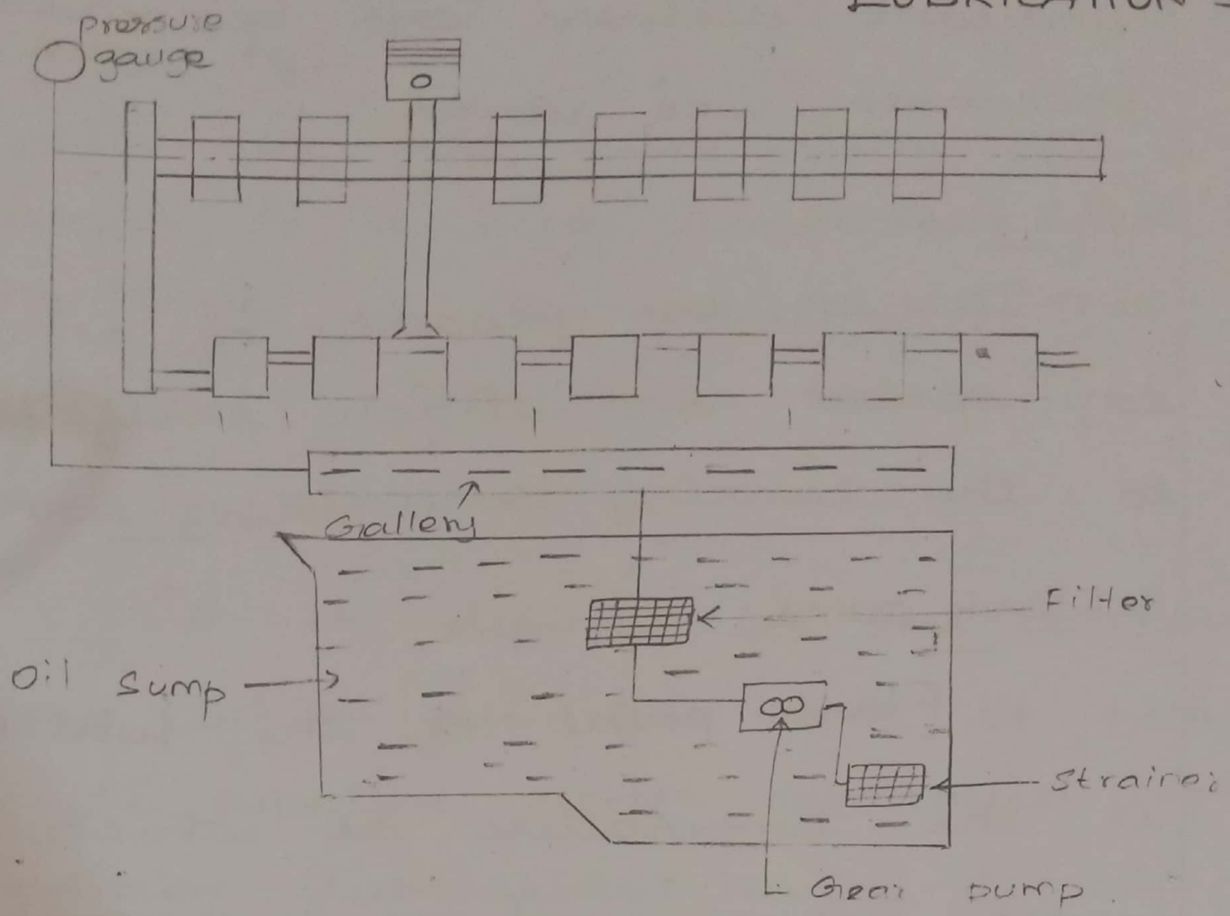
Drop feed oiler

b) SPLASH LUBRICATION :-



In this system the oil is stored in a sump which is at the bottom of crank

c) PRESSURE LUBRICATION (OR) SEMI PRESSURE LUBRICATION SYSTEM



PROPERTIES OF LUBRICATION :-

The lubricant used in IC engine should have some properties for the successful performance of the IC engine

1. Viscosity :-

Viscosity is defined as the measure of fluid resistance to flow. viscosity of the lubricant is depending upon its temperature. Viscosity of lubricant decrease as temperature increases, vice versa

2. Oilness :-

It is the property of an oil to spread and attach itself firmly to the bearing surfaces.

3. Flash point :-

Flash point of the lubricant is the temperature at which it forms vapour and produces combustible mixture with air. The high flashpoint is always desirable because low flash point leads to burning of lubricant. The minimum flashpoint of lubricating oil used in IC engine varies from 200 to 250° C.

4. Fire point :-

The Firepoint is the lowest temperature at which the fuel burns continuously. Fire point should be higher than the flash point.

5. Volatality:-

When the lubricating oil is exposed to a high temperature for a long time it may evaporate. This property is known as volatality.

6. Pour point:-

It is defined as the temperature below which oil will cease to flow in the pipeline under controlled test condition lubricants having lesser pour point.

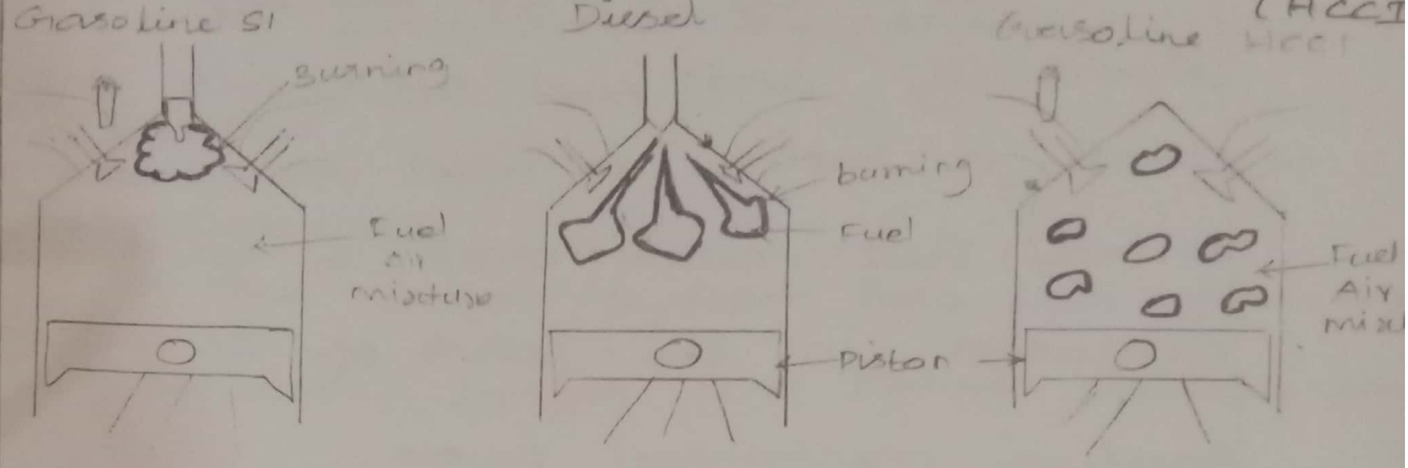
7. Foaming:-

It is the condition in which minute air bubbles are held in the oil. It will reduce the mass flow and also accurate oxidation.

UNIT-V

MODERN TECHNOLOGIES IN IC ENGINES

1) Homogeneous charge compression ignition (HCCI)



It is an internal Combustion in which well mixed fuel and atmospheric air are compressed to auto ignition poi

HCCI has two forms of Combustion.

* Homogeneous charge spark igniti
* Stratified charge compression ignit

Gasoline works under homogeneous charge spark ignition method and it is also known as HCSI. Diesel engine wort under stratified charge compression ignit method which is also known as SCCI.

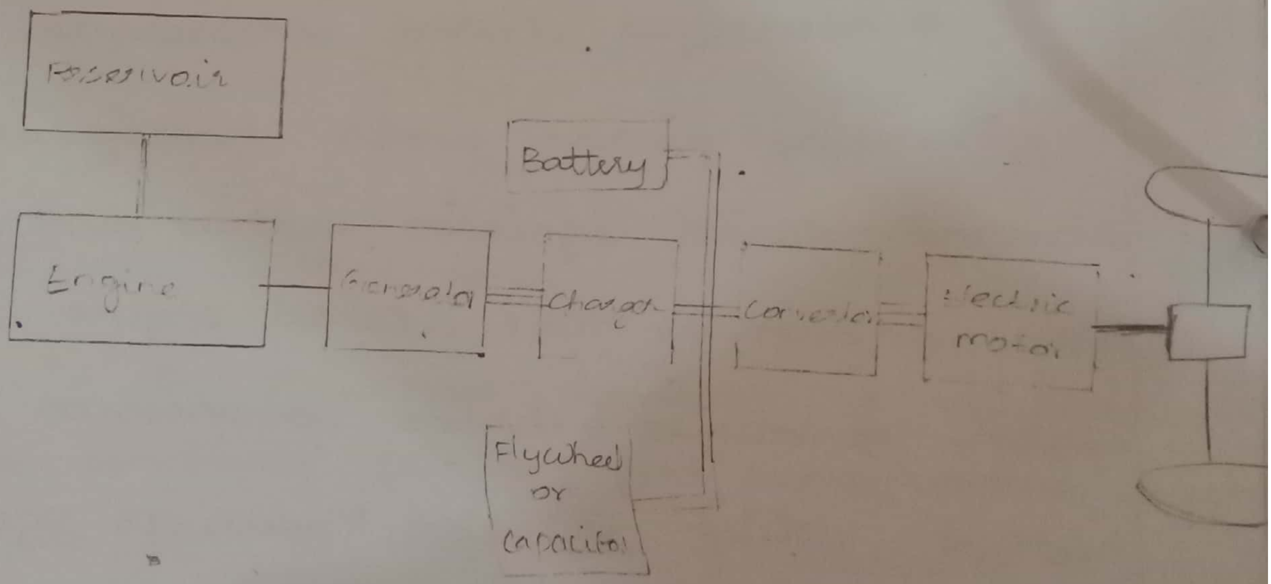
Hybrid electric Technology:-

A hybrid electric vehicle has two types of energy storage units by electricity and fuel. Electricity means that a battery is used to store the energy. Fuel means that a tank is required in the form of IC engine to produce mechanical power.

Types :-

* Series System
* Parallel system
* Combined system

Series System :-



The Engine drives an electric generator instead of driving the wheels. The electric motor provides power to the wheels.

Advantages:-

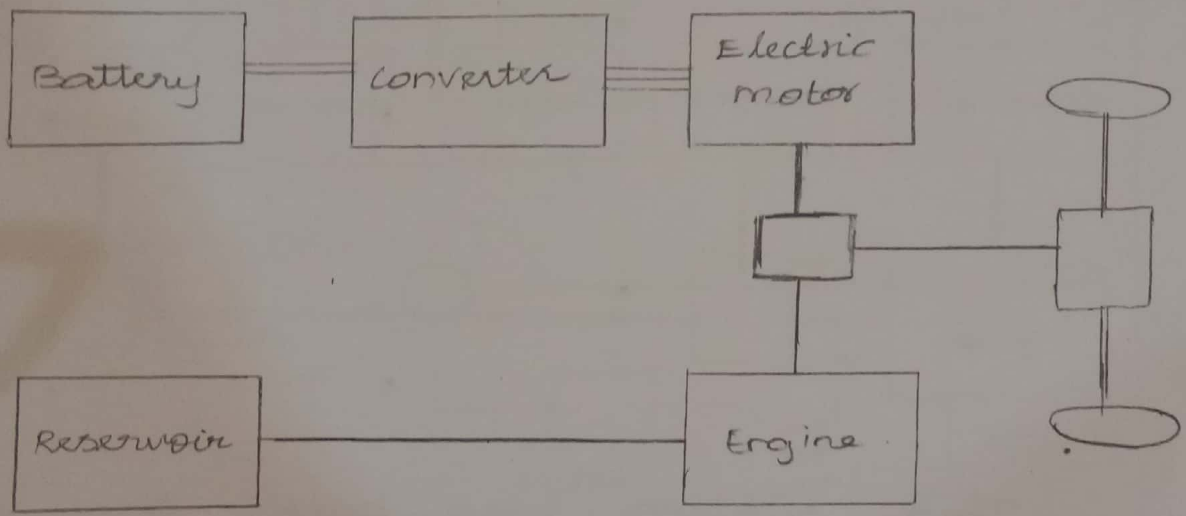
* No mechanical link between the combustion engine and its wheel.

* No conventional transmission element are placed.

Disadvantages

* The series system has less efficient. It requires larger and heavier battery back.

Parallel system:-



In this system, both heat engine and electric motor are directly connected by the mechanical transmission to the vehicle wheels.

Advantages:-

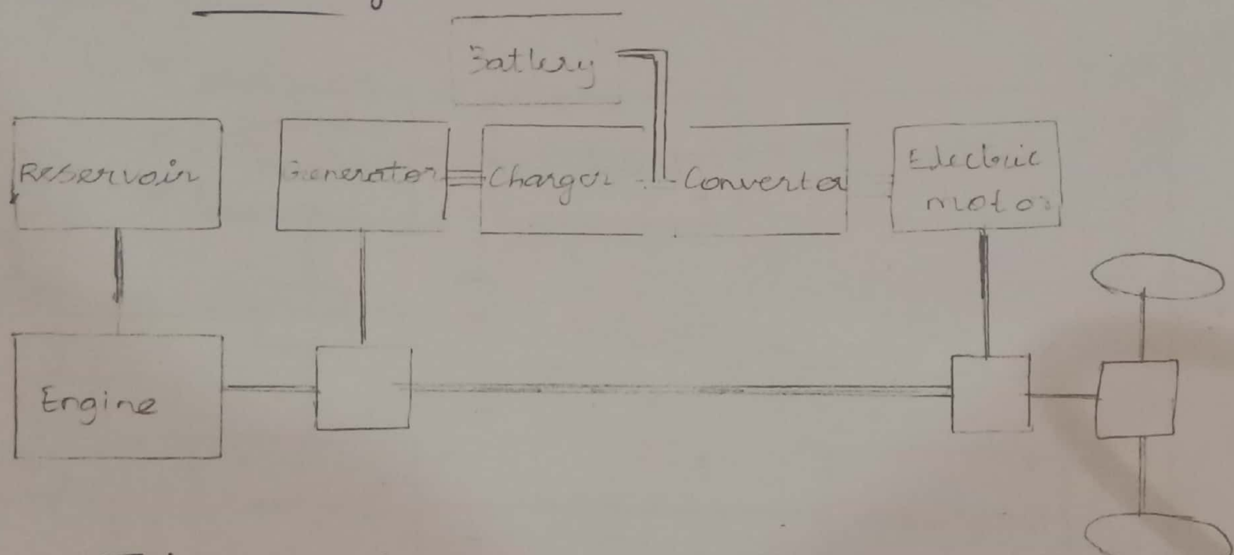
* Total efficiency is higher at long distance and highway driving.

* Larger flexibility to switch ove
between electric motor and heat engine pa

Disadvantages

* Complicated system
* When heat engine does not operate in correct rpm, the efficiency will drop at low speed.

Combined System:-



This system has both the features of series and parallel hybrid. The double connection is made between heat engine and electric motor.

Advantages:-

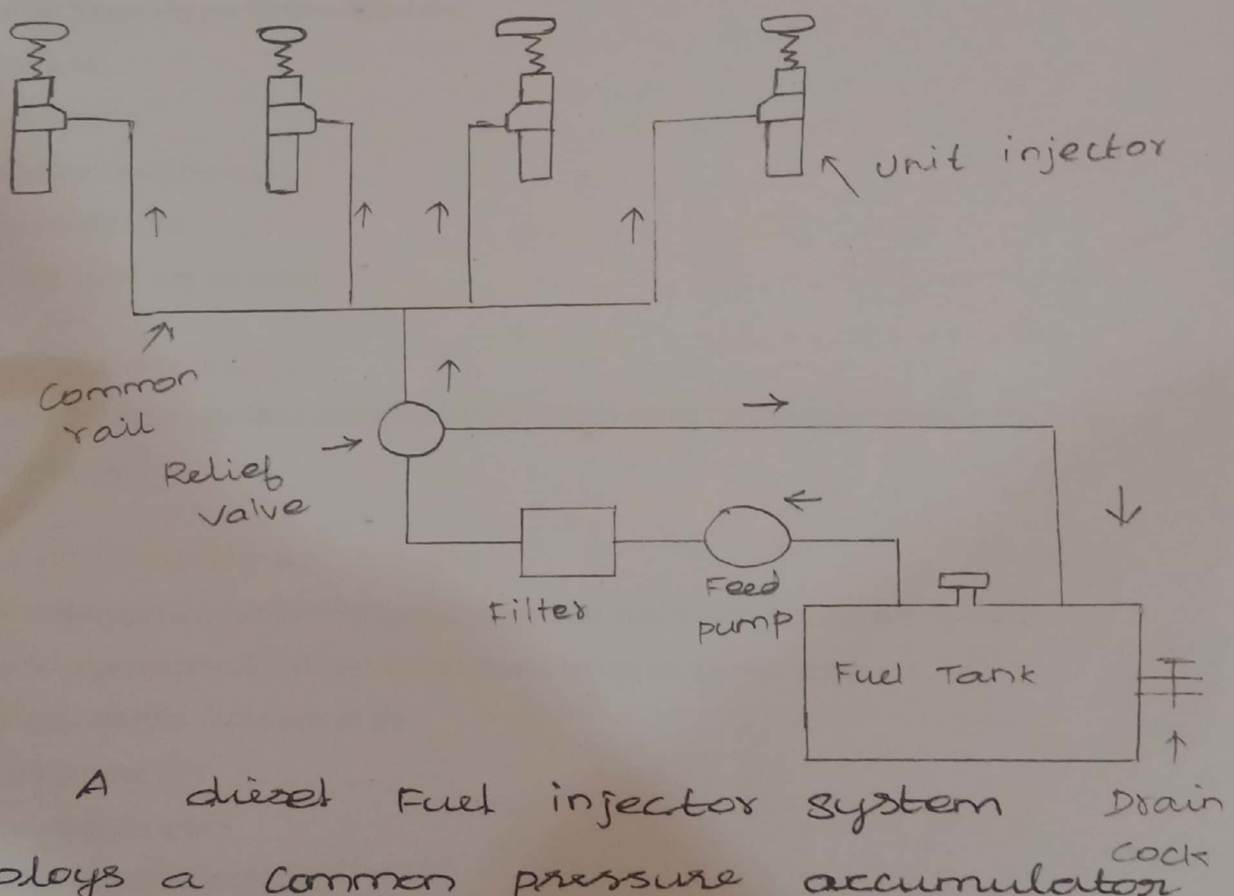
* It has maximum flexibility to switch over between electric and heat engine powers.

Disadvantages.

*. The combined system is more expensive than other system.

*. The power train transmission efficiency is poorly based on the amoun of power being transmitted.

3) Common rail direct injection Engine :-



A diesel fuel injector system employs a common pressure accumulator called the rail which is mounted along the engine block. The rail is fed by a high pressure fuel pump. The injector which are feed from the common rail are activated by solenoid valves.